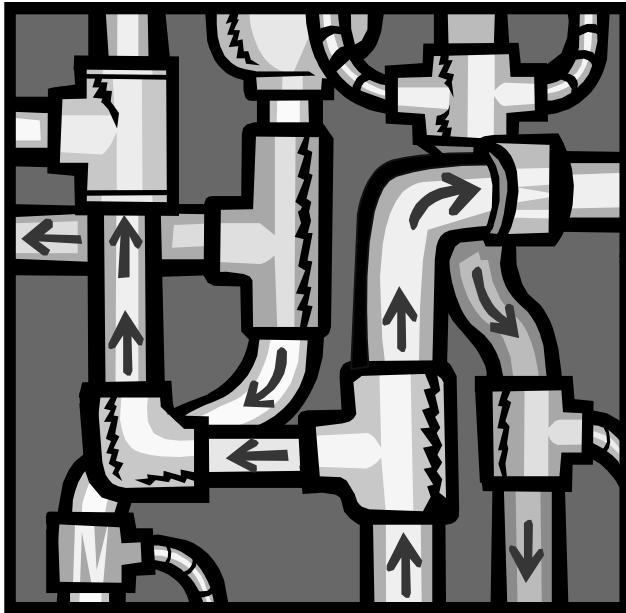


Water Works **Certification Program Guideline**



July 2003



DOH #331-109 (REV. 7/1/03)

Water Works **Certification Program Guideline**

July 2003



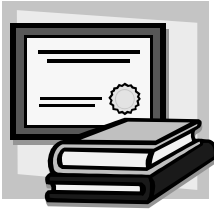
For more information or additional copies of this report contact:

Water Works Certification Program
Office of Drinking Water
Department of Health
PO Box 47822
Olympia, WA 98504-7822
(360) 236-3141

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Mary Selecky
Secretary of Health

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Introduction

**Mission
Statement**

The mission of the Department of Health, Office of Drinking Water is to protect the health of the people of the Washington State by providing safe and reliable drinking water.

**Certification
Program**

The Water Works Operator Certification Program is administered by the Department of Health (DOH) in coordination with the Water Works Operator Certification Advisory Committee. DOH is responsible for conducting routine program activities. The program goal is to ensure safe, efficient and effective operation and management of public water systems. The committee provides advice to DOH.

Water systems are required to employ certified operators to carry out various operational functions. To become certified, operators must meet minimum education and experience requirements and pass an examination. In addition, certified operators must meet a professional growth requirement every three years to maintain their certification status.

The program is self-sufficient, and fees are charged to water systems and operators for services provided by the program. These services include such activities as: enforcement actions, evaluation of education and training, professional growth requirements, career development, and operator listings.

**Legal
Authority**

The Water Works Operator Certification Program operates under the authority of Chapter 70.119 RCW. More detailed and comprehensive program regulations are contained in Chapter 246-292 WAC.

**Guideline
Purpose**

The Water Works Certification Program Guideline is designed to assist water systems and operators in meeting program requirements. To accomplish this, the guideline provides information beyond that presented in regulations, including: how water systems are classified, education and experience requirements of different classifications of operators, procedures for obtaining and renewing certification, and how to meet professional growth requirements.

**Guideline
Applicability**

This document is intended for use by water system purveyors and individuals who desire to be certified operators in the State of Washington. It is divided into two main sections. The first section contains information regarding water systems and the second section provides information pertaining to operators and the certification process. The guideline will also be used extensively by DOH in carrying out program administrative responsibilities.

**For Further
Information**

Questions about information contained in this guideline, or requests for additional information about the **Water Works Operator Certification Program**, should be directed to:

Water Works Operator Certification Program

Office of Drinking Water

PO Box 47822

Olympia, WA 98504-7822

website:

http://www.doh.wa.gov/ehp/dw/Our_Main_Pages/opcertification.htm

Cheryl Bergener, Program Manager 360/236-3137, 800/525-2536, Ext. 4

- Certification Requirements for Large Group A Community Systems
- Certification Requirements for Filtered Systems
- Operator Education and Experience Requirements
- Certification Appeals

Judy Jones, Deputy Program Manager 360/236-3139, 800/525-2536, Ext. 3

- Certification Requirements for Small Water Systems
- Operator Education and Experience Requirements
- Operator Renewals
- General Certification Information

Denise Garrett-Berry, 360/236-3099, 800/525-2536, Ext. 6

- Compliance Issues for Certification Violations

Gael Rose-Kantz, 360/236-3145, 800/525-2536, extension 5

- Temporary Certification Applications and Information
- Contract Operator Requirements and Public Listing

Larry Granish, 360/236-3141, 800/525-2536, Ext. 7

- Application Packets
- Address Changes
- Renewal Questions

WETRC

Questions about the **Professional Growth Program & the Backflow Assembly Tester Program** should be directed to:

Washington Environmental Training Center (WETRC)

Green River Community College

12401 SE 320th Street M/S WW

Auburn, WA 98092-3699

Website: <http://www.wetrc.org>

Peggy Barton, Associate Director, Certification Services 253/288-3369, 800/562-0858, Ext. 2

- Water Works Operator Professional Growth Program
- Water Works Training Evaluation and CEU Assignment

David Kingsley, Backflow Assembly Tester Program Manager 253/288-3371, 800/562-0858, Ext. 3

- Backflow Assembly Tester Certification and Professional Growth Records
- Backflow Assembly Tester Certification Renewal

Gregory Lund, Training Coordinator 253/288-3373, 800/562-0858, Ext. 5

- WETRC Workshop Information
- Backflow Assembly Tester Certification Examination Registration
- Backflow Assembly Tester Professional Growth Examination Registration

Regional Technical Assistance

The Regional Drinking Water Operations offices are open Monday through Friday 8:00 A.M. to 5:00 P.M. Staff is available to assist with most questions immediately. As necessary, other questions will be referred to the appropriate staff for response.

Regional Engineers are responsible for the implementation of the state's drinking water program in assigned counties. They conduct sanitary surveys and special purpose investigations of public water systems and promote needed water facility improvements. They also review and approve water system plans and specifications for system improvements and provide technical assistance to purveyors and local health departments upon request.

Visit our web site at: www.doh.wa.gov/ehp/dw

Department of Health, Drinking Water Regional Offices

Eastern Regional Office
1500 West 4th Ave, Suite 305
Spokane, Washington 99204
509/456-3115

Counties served: Adams, Asotin,
Benton, Chelan, Columbia, Douglas,
Ferry, Franklin, Garfield, Grant, Kittitas,
Klickitat, Lincoln, Okanogan, Pend
Oreille, Spokane, Stevens, Walla Walla,
Whitman and Yakima

Southwest Regional Office
Post Office Box 47823
Olympia, Washington 98504-7823
360/664-0768

Counties served: Clallam, Clark,
Cowlitz, Grays Harbor, Jefferson,
Kitsap, Lewis, Mason, Pacific,
Skamania, Thurston and Wahkiakum

Northwest Regional Office
20435 72nd Avenue South, Suite 200
Kent, Washington 98032
253/395-6750

Counties served:
Island, King, Pierce, San Juan, Skagit,
Snohomish and Whatcom

After-Hours (Only) Hotline for Drinking Water Emergencies
Toll free 1-877-481-4901



Water System Section

Certification Applicability

The Water Works Operator Certification Regulations, chapter 246- 292 WAC requires the following public water systems to have an appropriately certified operator in responsible charge of daily operational activities:

- All Group A* Community or Nontransient Noncommunity (NTNC) systems as defined by chapter 246-292-010 WAC;
- Group A Transient Noncommunity (TNC) systems classified as “Significant Noncompliers” (SNCs); and
- Group A Transient Noncommunity (TNC) systems using surface water or groundwater under the influence of surface water (GWI).

Note: A designated certified operator shall be in responsible charge and available for each operating shift.

**Group A water systems are defined as public water systems that serve a population of 25 or more and/or have 15 or more service connections.*

Mandatory Certified Operator Responsibilities

Public health is protected through competent operators of public water supplies. A certified operator is someone who has met the requirements for the specified operator classification of the Water Works Operator Certification Program. The person in responsible charge of the operation of all Group A community or nontransient noncommunity (NTNC) water systems, transient noncommunity (TNC) water systems that become significant non-compliers (SNCs), and transient noncommunity (TNC) water systems using a surface water or groundwater under the influence (GWI) are required to be certified.

"Responsible charge" means the operator(s) designated by the owner to be the certified operator(s) who makes the decisions regarding the daily operational activities of a public water system, water treatment facility and/or distribution system that will directly impact water quality and/or quantity of drinking water including, but not limited to, decisions concerning process control and system integrity.

The typical public health related responsibilities and activities associated with the operation of a public water system include the following:

1. Ensure that all daily operation and maintenance activities of the water system are completed in accordance with acceptable public health practices and water industry standards.
2. Perform water quality monitoring, maintain adequate records and take follow-up action, if necessary, to comply with state and federal drinking water regulations.
3. Implement preventative maintenance programs; and inspect treatment and other system components for malfunctions; keep adequate records; and make needed repairs.
4. Analyze/review recording instrument readings and laboratory tests; determine sites and causes of any malfunctions; adjust various treatment processes or other components accordingly; and maintain a record of these.
5. Implement a cross-connection control program.
6. Determine remedial actions in emergencies.

Distribution Systems

Distribution systems are defined as Group A public water systems that convey water from the source and/or treatment facilities to consumers. They are classified by the department into five groups:

Population Served	Classification	Certification Requirement
Less than 251	Group S	WDS
251 to 1,500	Group 1	WDM 1
1,501 to 15,000	Group 2	WDM 2
15,001 to 50,000	Group 3	WDM 3
Greater than 50,000	Group 4	WDM 4

The population served is based on information provided by public water systems on their Water Facilities Inventory (WFI) forms. If the population served is not known, multiply the number of service connections by 2.5.

Purification Plants

Purification plants are defined as public water systems that treat or improve the physical, chemical, or bacteriological quality of the system's water to bring the water into compliance with State Board of Health standards. Treatment processes installed to perform water filtration, ion exchange, electrodialysis, reverse osmosis, or iron and manganese removal are included within the scope of the term purification plant. Treatment processes installed to allow in-line fluoridation, in-line chlorination, or chemical additions to inhibit corrosion are not included within the scope of the term purification plant.

1. Purification plants are classified by the department into two categories:
 - A. Purification plants utilizing basic filtration technology; or
 - B. Purification plants utilizing complex filtration technology.
2. The department classifies purification plants utilizing complex filtration technology into four groups based on the Association of Boards of Certification (ABC) "Purification Plant Criteria". The classification schedule is as follows:

Total Points Assigned	Classification	Certification Requirement
Less than 31	Group 1	BTO
31 to 55	Group 2	WTPO 2
56 to 75	Group 3	WTPO 3
Greater than 75	Group 4	WTPO 4

The certified operator in responsible charge of each operating shift shall be certified at a minimum of one level lower than the classification of the purification plant or distribution system.

Sample Scenarios

1. A water system serving a population of 347 people and requires no treatment other than chlorination, requires a WDM 1.
2. A water system serving a population of 136 people and a Group 1 purification plant rating requires a WDS and a BTO.
3. A water system serving a population of 1,550 and a Group 2 purification plant rating requires a WDM 2 and a WTPO 2.
4. A water system serving a population of 26,000, a Group 3 purification plant rating, and has three shift operators in the purification plant requires a WDM 3, a WTPO 3 and shift operators certified as WTPO 2.

(DRAFT)

Guidelines for Use of ABC Purification Plant Criteria Worksheet

APPLICABILITY OF THE WORKSHEET

WAC 246-292-010 defines "purification plant" as that portion of a public water system that treats or improves the physical, chemical or bacteriological quality of the system's water to bring it into compliance with state board of health standards. Unit processes installed to perform filtration, ion exchange, electrodialysis, reverse osmosis, or iron and manganese removal shall be included within the scope of the term purification plant. **Unit processes installed to allow in-line fluoridation, in-line chlorination, or chemical addition to inhibit corrosion are not included within the scope of the term purification plant.** Exception: a treatment operator shall be responsible for operation of any *unfiltered* Group A surface water or GWI system (WAC 246-292-050).

For multiple treatment facilities on same system: plants are rated individually, however whole system population is used unless the portion of a system served by a particular plant is physically isolated and its service population is known. Operators in systems having multiple treatment facilities must either be assigned to a specific plant, or must be certified for the highest-rated plant on that system. The Water Works Operator Certification Program will maintain rating records for all plants, but will classify systems on the basis of the highest-rated plant.

If a process is provided remotely, but is integral to treatment, then consider it part of the treatment plant (e.g. chlorination in a raw water pipeline used for CT compliance). However, if treatment is supplemental in nature, and operation and monitoring is provided separately from the plant, then this may be considered not a part of the treatment plant (e.g. chlorination at a remote booster station).

SIZE

Maximum population served. Total population receiving water from the plant, including the population served by any consecutive systems.

Design flow. Consider this to be the design capacity of the plant.

WATER SUPPLY SOURCES

Groundwater. Only give points if there is treatment for a primary contaminant (i.e. "purification"). Include Seawater/saltwater sources in this category.

Average raw water quality variability. Applies to all sources (surface and groundwater). Key is the effect on treatment process changes that would be necessary to achieve optimized performance.

- Little or no variation - no treatment provided except disinfection - (0 points)
- Minor variation - e.g. "high quality" surface source appropriate for slow sand filtration - (2 points)
- Moderate variation - chemical feed dosage changes made: at least weekly (3 pts), daily (4 pts), or with each 8-hour shift (6 pts)
- High variation – requires frequent changes in treatment (several times daily), raw water quality variability may be due to agricultural and/or municipal waste discharges - (8 points)
- Extreme variation – may be from periodic serious industrial, agricultural or municipal waste pollution - (10 points)

Raw water is subject to or has elevated. If typically occurring on a routine basis;

- **Taste and/or odor levels** will be considered elevated when: 1) T&O issue has been identified in a pre-design report, etc., 2) a process has been installed to address, and 3) operational control adjustments are made at least seasonally. Do not give points for T&O when there is no specific additional impact on operation. E.g. if a system is already pre-chlorinating for disinfection, give no points for T&O.
- **Color** will be considered elevated when levels exceed 75 Color Units (CU) for conventional filtration, 40 CU for direct filtration, or 15 CU for all other technologies, except reverse osmosis (no limits).

- **Iron and/or Manganese.** Except for applications of manganese greensand treatment, will be considered elevated when their combined level exceeds 1.0 mg/l. (No limits apply for Mn/greensand systems.)
- **Turbidity.** No restrictions or limitations apply for conventional filtration. Turbidity will be considered elevated when levels exceed 14 NTU for direct and in-line filtration, 10 NTU for slow sand filtration, and 5 NTU for pre-coat (diatomaceous earth), cartridge and bag filters. Limits do not apply to membrane technologies. Note these values apply for turbidity not due to precipitated metals. For unfiltered systems: apply points only if source *blending or source shutdown* is used to achieve/maintain SWTR compliance.
- **Coliform** will be considered elevated when levels exceed 20,000 CFU/100 mL (as total coliform) for conventional filtration, 5,000 for direct filtration, 500 for direct and in-line filtration, 800 for slow sand filtration, and 50 for pre-coat (diatomaceous earth), cartridge and bag filters. Limits do not apply to membrane technologies. For unfiltered: Fecal coliform levels which trigger a “filtration decision.”
- **Algal growths.** Raw water will be considered subject to algae growths when treatment processes are specifically adjusted due to the presence of high levels of algae on at least a weekly basis for at least two months each year.

Raw water is subject to periodic pollution: Points are to be accrued when a source of pollution is “consistent enough to cause problems that need to be addressed by the operator” on at least a daily basis.

CHEMICAL TREATMENT/ADDITION PROCESS

Chemical addition – 1 point (each) for any coagulant, coagulant aid, flocculant, or filter aid.

Liquid or powdered chlorine includes on-site generated hypochlorites, and tablet feeders.

UV Disinfection – 5 points.

pH adjustment – chemical addition for process control purposes (e.g. pH adjustment aids coagulation)

Chloramination – 5 points, same as chlorination/chlorine dioxide.

KMnO₄ – 2 points. If used with greensand filtration do not give 2 points.

Stability or Corrosion Control – If the same chemical is used for both Corrosion Control and pH adjustment, count points only once -- for Corrosion Control (10 points).

COAGULATION & FLOCCULATION PROCESS

Mechanical mixers are motor driven, turbine or propeller mixers. Also known as back-mixers.

Injection mixers are those that utilize diffusion mixing by pressurized water jets.

In-line blender mixers are in-pipe motor-driven impeller rapid mixers. These do not include in-line static (motionless) mixers. Static mixers get zero points, as do hydraulic mixers (Parshall flume, venturi and weir).

Hydraulic flocculators includes horizontally and/or vertically baffled channels, pipe nozzles, and windowed baffles.

Mechanical flocculators includes shaft driven turbines, blades or paddles (including Walking Beam).

CLARIFICATION/SEDIMENTATION PROCESS

Up-flow solid-contact sedimentation is also known as sludge blanket clarification. Includes such proprietary units as Super-Pulsator. These units include processes for flocculation and sedimentation. Important note: these are not the same as adsorption clarifiers.

Adsorption clarifiers – give 10 points under Special processes/other.

Other proprietary clarification processes – Actiflo, etc. Give 10 points under Special processes/other.

FILTRATION PROCESS

Single media filtration. Sand filter used in complete conventional filtration. Also simple single media processes such as Pyrolox® (pyrolusite) or Birm® filtration –but not greensand (see below). Does not include deep bed monomedia (see “Direct Filtration”), or slow sand filtration.

Microscreens includes membrane filtration (microfiltration and/or ultrafiltration), but not RO (see below).

Cartridge filters includes bag filtration. With or without any non-chemical pre-filtration (e.g. staged cartridges, pressure sand filtration).

Direct filtration includes in-line filtration and deep bed monomedia filtration.

Pressure or greensand filtration – Pressure filtration (for surface sources), and manganese greensand oxidative filters (with or without anthracite cap) –20 points. Points assigned for greensand filtration assume a complete process train, including pretreatment (pre-oxidation), filtration and residuals disposal, but not fluoridation, disinfection, or corrosion control.

SPECIAL PROCESSES

Other. For processes not specifically listed, assign 2 – 15 points based upon comparison with equivalent treatment of similar complexity.

RESIDUALS DISPOSAL

Pick the one category (out of the eight) that best represents disposal practice at the plant.

Discharge to raw water source -- can be recycling to plant, or to lake/reservoir.

On-site disposal – pertains to dry solids residuals disposal.

Land application – pertains to liquid residuals disposal (and there is no NPDES permit).

FACILITY CHARACTERISTICS

No process operation – plant has no automated shutdown capability.

Limited process operation – automated alarm and shutdown for turbidity, chlorine, level, etc.

Moderate process operation – alarms and shutdown, plus partial remote operation of plant.

Extensive/total process operation – alarms and shutdown, full remote operation of plant possible.

Clearwell size applies only to systems treating for a primary contaminant. Total distribution storage available prior to first customer may be counted if it may be drawn upon. If there is no clearwell, points are given.

WASHINGTON STATE DEPARTMENT OF HEALTH

ABCPURIFICATION PLANT CRITERIA WORKSHEET

ABC Classification:

Water Treatment Plant - address and contact person

Plant Name	WA WFI #
Contact Name and Title	
Address	
City/State/Zip	
Phone and Fax	

A groundwater supply with only chlorination is considered a distribution system, not a water treatment facility. The addition of any chemical to a public water supply, other than a disinfectant, will be considered a treatment facility and should use this rating worksheet to determine the classification of the facility*. Unless otherwise noted, give full amount of points in the "Your Plant" box.

For example:

	Raw water quality is subject to or has elevated:	Points	Your Plant
Correct:	Taste and/or odor levels	3	3
Incorrect:	Taste and/or odor levels	3	1

Do not double count. If the plant has two horizontal-flow (rectangular basins), **DO NOT** give 10 points, give 5 points. If the plant has more than one type of unit for each process, give points once for each unit.

*With the exception of unit processes installed to allow in-line fluoridation, in-line chlorination, or chemical addition to inhibit corrosion are not included within the scope of the term "purification plant" per WAC 246-292-010.

Item	Points	Your Plant
Size (2 point minimum to 20 point maximum)		
Maximum population or part served, peak day (1 pt minimum to 10 pt maximum) Examples: 27,000 people served = 3 pts 13,000 people served = 2 pts (Round up to the next whole number)	1 pt per 10,000 or part	
Design flow average day or peak month's part flow average day, whichever is larger (1 pt minimum to 10 pt maximum) Examples: 9.2 MGD = 10 pts 4.7 MGD = 5 pts (Round up to the next whole number)	1 pt per MGD or part	
Water supply sources		
Groundwater	3	
Groundwater under the influence of surface water	5	
Surface water	5	
Average raw water quality varies enough to require treatment changes 10% of the time with a range of 0 to 10 with the following guidelines: Little or no variation = 0 points High variation. (Raw water quality subject to periodic serious industrial waste pollution) = 10 points	0—10	
Raw water quality is subject to or has elevated:		
• Taste and/or odor levels	3	
• Color levels	3	
• Iron and/or manganese levels	5	
• Turbidity levels	5	
• Coliform and/or fecal counts	5	
• Algal growths	5	
Raw water quality is subject to periodic:		
• Industrial and commercial waste pollution	5	
• Agricultural pollution	5	
• Urban runoff, erosion, and storm water pollution	3	
• Recreational use (boating, fishing, etc.)	2	
• Urban development and residential land use pollution	2	
Chemical Treatment/Addition Process		
Fluoridation	5	
Disinfection		
• Gaseous chlorine	5	
• Liquid or powdered chlorine	5	
• Chlorine dioxide	5	
• Ozonization (on-site generation)	10	
pH adjustment (Calcium carbonate, carbon dioxide, hydrochloric acid, calcium oxide, calcium hydroxide, sodium hydroxide, sulfuric acid, other)	5	
Stability or Corrosion Control (Calcium oxide, calcium hydroxide, sodium carbonate, sodium hexametaphosphate, other)	10	

PURIFICATION PLANT CRITERIA WORKSHEET (cont.)**Coagulation & Flocculation Process**

Chemical addition (1 pt for each type of chemical coagulant added, maximum 5 pts) (Aluminum sulfate, bauxite, ferrous sulfate, ferric sulfate, calcium oxide, bentonite, calcium carbonate, carbon dioxide, sodium silicate, other)	5	
Rapid mix units		
• Mechanical mixers	3	
• Injection mixers	2	
• In-line blender mixers	2	
Flocculation tanks		
• Hydraulic flocculators	2	
• Mechanical flocculators	3	

Clarification/Sedimentation Process

Horizontal-flow (rectangular basins)	5	
Horizontal-flow (round basins)	7	
Up-flow solid-contact sedimentation	15	
Inclined-plate sedimentation	10	
Tube sedimentation	10	
Dissolved air flotation	30	

Filtration Process

Single media filtration	3	
Dual or mixed media filtration	5	
Microscreens	5	
Diatomaceous earth filters	5	
Cartridge filters	5	
Slow sand filters	5	
Direct filtration	5	
Pressure or greensand filtration	20	

Other Treatment Processes

Aeration	3	
Packed tower aeration	5	
Ion-exchange/softening	5	
Lime-soda ash softening	20	
Copper sulfate treatment	5	
Powdered activated carbon	5	
Special Processes (reverse osmosis, electrodialysis, other)	15	

Residuals Disposal

Discharge to lagoons	5	
Discharge to lagoons and then raw water source	8	
Discharge to raw water	10	
Disposal to sanitary sewer	3	
Mechanical dewatering	5	
On-site disposal	5	
Land application	5	
Solids composting	5	

Facility Characteristics

Instrumentation (Choose only one of the following)		
• Use of SCADA or similar instrumentation systems to provide data w/ no process operation	0	
• Use of SCADA or similar instrumentation systems to provide data w/ limited process operation	2	
• Use of SCADA or similar instrumentation systems to provide data w/ moderate process operation	4	
• Use of SCADA or similar instrumentation systems to provide data w/ extensive or total process operation	6	
Clearwell size less than average day design flow	5	
	Total Points	

See WAC 246-292-050 for minimum certification requirements:

(Revised 07.10.02)

Class I 30 points or less

Class III 56-75 points

Class II 31-55 points

Class IV 76 points and greater

Form Completed by: _____ Date: _____

System Temporary Operator Certification

If a certified operator for a water system leaves their mandatory position for any reason, the system is required to inform the department and fill the vacant position within thirty days. To maintain compliance status the system must hire an appropriately certified operator, a contract operator, or apply for a temporary certification for an individual who is not properly certified and who meets the certification requirements.

When a system wishes to hire an operator who is not certified or not certified at the appropriate level, the Department of Health may issue a temporary certification on request by the system. The temporary will only be granted if DOH criteria have been met. Only one temporary certification may be issued in each instance of any position vacancy and it may be valid for up to twelve months (normally from the date the position became vacant).

To request a temporary certification the system must submit:

- A letter requesting temporary certification for the operator
- The temporary certification application (needs to be signed by the operator and the system)
- Temporary application fee

System Certification Fees

Group A system fees shall be as indicated and are subject to change.

Annual System Fees:

System Size (Number of Equivalent Services)	System Fee**
Less than 601 connections	\$100.00
601 through 6,000 Services	\$304.00
6001 through 20,000 Services	\$405.00
More than 20,000 Services	\$610.00

**The late fee shall be based on the water system's classification and shall be an additional 10 percent of the system fee or twenty-seven (\$27.00) dollars, whichever is greater.

The system fee for issuance of a temporary certification shall be sixty-six dollars (\$66.00) for each temporary position.

System Compliance and Enforcement

The Department of Health Office of Drinking Water and the US Environmental Protection Agency (USEPA) consider compliance with the operator certification regulations (WAC 246-292) a high priority. The Water Works Certification Program (Certification Program) is required to provide quarterly compliance reports to the USEPA, documenting information on system compliance and enforcement efforts.

All systems and certified operators are responsible for providing complete and accurate information to the Certification Program office. The water system representative should report all changes regarding mandatory operator positions. Certified operators should report employment changes, home address, and telephone number corrections. All corrections need to be reported promptly.

All water system enforcement or compliance-related documentation is sent to the system's mailing address.

The Certification Program's compliance/enforcement process is as follows:

Phase 1 – Informal Notification Letters and Telephone Calls

Systems that may be out of compliance with the operator certification regulations are notified and provided technical assistance. Compliance dates are set with every effort made by Certification Program staff to work with systems and operators to help them achieve compliance. At the same time, the system's operating permit is categorized as "Yellow" and the system is considered to be in conditional compliance.

Phase 2 – Notice of Violation (NOV)

At Phase 2, it has been established that a violation of the operator certification regulations has occurred. Systems that have refused to respond to Certification Program contact or that have consistently exceeded scheduled compliance dates are issued a Notice of Violation. There are limited compliance options available at this point.

Phase 3 – State Departmental Order (SDO)

Systems that receive a State Departmental Order from the Certification Program are considered to be State Significant Noncompliers (SSNCs). Systems will have their operating permits turned "Red" if they do not comply with the Order.

Phase 4 – Notice of Imposition of Penalties (NIP)

Systems that receive a Notice of Imposition of Penalties for noncompliance with the operator certification regulations may face civil penalties of up to \$5,000 per day, per violation. Possible criminal misdemeanor charges with fines up to \$100 per offense can also be issued (WAC 246-292-110 (4), (5)).

Additional legal actions can be pursued by the Attorney General's office or local prosecutors (WAC 246-292-110 (7)).



Operator Section

Mandatory Operator Responsibilities

Public health is protected through competent operators of public water supplies. A certified operator is someone who has met the requirements for the specified operator classification of the Water Works Certification Program. The person in responsible charge of the operation of all Group A community or nontransient noncommunity (NTNC) water systems, transient noncommunity (TNC) water systems that become significant non-compliers (SNC), and transient noncommunity (TNC) water systems using a surface water or groundwater under the influence (GWI) are required to be certified. Once certified, all operators are required to meet renewal and professional growth requirements (see pages 23 - 26).

"Responsible charge" means the operator(s) designated by the owner to be the certified operator(s) who makes the decisions regarding the daily operational activities of a public water system, water treatment facility and/or distribution system that will directly impact water quality and/or quantity of drinking water including, but not limited to, decisions concerning process control and system integrity.

The typical public health related responsibilities and activities associated with the operation of a public water system include the following:

1. Ensure that all daily operation and maintenance activities of the water system are completed in accordance with acceptable public health practices and water industry standards.
2. Perform water quality monitoring, maintain adequate records and take follow-up action, if necessary, to comply with state and federal drinking water regulations.
3. Implement preventative maintenance programs; and inspect treatment and other system components for malfunctions; keep adequate records; and make needed repairs.
4. Analyze/review recording instrument readings and laboratory tests; determine sites and causes of any malfunctions; adjust various treatment processes or other components accordingly; and maintain a record of these.
5. Implement a cross-connection control program.
6. Determine remedial actions in emergencies.

Contract Operator

Contract operators are those who are designated as the certified operator for three or more public water systems (including Group B), WAC 246-292-055. They must at a minimum be certified as Water Distribution Manager (WDM level determined by the population of the largest public water system operated) and Cross Connection Control Specialist (CCS). Other classifications may be needed depending upon the specific systems involved. Contract operators must be available 24-hours per day and they must provide two copies of all signed operations contracts to the Department of Health within 30 days of the effective date. These requirements also apply to mandatory operators of Satellite Management Agencies.

Contract operators in compliance with the regulation are posted on the public contract operator listing and on our website http://www.doh.wa.gov/ehp/dw/Our_Main_Pages/opcertification.htm.

NOTE: Only contract operators who request to be on the public listing are posted on our website.

Education and Experience Requirements

To assure safe, efficient, and effective management, and operation of public water systems, minimum education and experience requirements for certification have been established. WAC 246-292-060 (1) lists the following minimum education and experience requirements for each water works operator classification and level:

CLASS	LEVEL									
	IT*		1		2		3		4	
	Education	Experience	Education	Experience	Education	Experience	Education	Experience	Education	Experience
WDM	12 years	3 months	12 years	1 year	12 years	3 years	14 years	4 years	16 years	4 years
WTPO	12 years	3 months	12 years	1 year	12 years	3 years	14 years	4 years	16 years	4 years

* In-Training (IT) experience may be fulfilled by three months operating experience or thirty hours of relevant classroom training (three CEUs or college credits).

Water Distribution Specialist (WDS)		Basic Treatment Operator (BTO)		Cross-Connection Control Specialist (CCS)		Backflow Assembly Tester (BAT)	
Education	Experience	Education	Experience	Education	Experience	Education	Experience
12 years	6 months	12 years	6 months	12 years	6 months	NA**	NA**

* Twelve years education equals high school diploma or equivalent.

Applicants for Level 1 certification may not substitute equivalent experience or college for any portion of the operating experience requirement. **Operating experience shall be the routine on-site performance of duties in a water purification plant or distribution system. Those duties shall affect plant or system performance and/or water quality.** Applicants for Levels 2, 3, or 4 may make substitutions. See *Experience Substitutions*, page 17.

College means credits earned toward a college degree or in course work relevant to the operation, maintenance, or management of a public water system; **and** which has an influence on water quality, public health, or environmental protection. College claimed by an applicant may be credited toward the certification requirements when documented on an official transcript or an unaltered copy.

DOH may allow substitutions of a person's relevant experience when the person cannot meet the formal education requirement, or substitute relevant education for experience, in the WDM, WTPO, WDS, BTO, and CCS classifications. See *Education Substitutions*, page 17.

****The BAT classification does not have an education and experience requirement, however, applicants must pass the appropriate examination (see page 26).**

Substitutions for Education and Experience

Education Substitutions

Listed below are accepted education substitutions:

1. A GED is equivalent to a high school diploma.
2. One year of excess operating experience may be substituted for one year of high school or two years of grade school - no limit.
3. Applicants for Level 3 and 4 certification may utilize **one** of the following education substitution options:

Option 1: One year of excess operating experience in a water purification plant or distribution system may be substituted for one year of required relevant college/CEU. This substitution can only be used for **up to half of the education (college) requirement**. If the applicant has less than one year of relevant college/CEU option 2 is required.

- OR -

Option 2: Verification of a high school diploma or GED and three years of excess operating experience in a water purification plant or distribution system with a classification rating not less than one classification lower than the level of certification desired for one year of relevant college - **no limit**.

Note: **Excess operating experience substituted for a WTPO classification must be in a public water purification plant classified at the appropriate level. To determine eligibility utilizing either option, contact the Certification Program Office.**

4. One year of college will mean 30 relevant semester credits, 45 relevant quarter credits, or 45 relevant continuing education units (CEU).
5. Operating experience substituted for an education requirement cannot also be applied to the operating experience requirement.
6. On-the-job training that receives college or CEU credit may be applied towards an education requirement or an experience requirement, but not to both.

Experience Substitutions

Listed below are accepted experience substitutions:

1. Three relevant CEU or college credits may be substituted for the three months of operating experience required for OIT applicants.
2. Applicants for certification for Water Treatment Plant Operator 2 through 4 must attain a minimum of half of the operating experience requirement in a public water purification plant utilizing complex filtration technology and classified not less than one classification lower than the level of certification being applied for.
3. Providing one year of operating experience has been obtained, applicants for Water Distribution Manager 2 through 4 may substitute relevant experience, college, CEU, or a combination year for year.

4. Providing one year of operating experience has been obtained, the following experience may be credited, provided the experience is water related:
 - A. Experience in a federal, state, county, local, etc., governmental agency;
 - B. Experience as an operations consultant;
 - C. Experience in industrial water system operations; or
 - D. Experience in other areas such as design, analysis, planning, construction, administration, management, etc.

Operator Certification Fees

Operator fees shall be as indicated and are subject to change.

Water Works Operator Fees:

Operator Classification	Application Fee	Reapplication Fee	Annual Renewal Fee	Late Fee
WTPO	\$66.00	\$32.00	\$32.00*	\$27.00**
WDM	\$66.00	\$32.00	\$32.00*	\$27.00**
WDS	\$66.00	\$32.00	\$32.00*	\$27.00**
CCS	\$39.00	\$32.00	\$32.00*	\$27.00**
BAT	\$39.00	\$32.00	\$32.00	\$27.00
BTO	\$39.00	\$32.00	\$32.00*	\$27.00**

* The annual renewal fee for a WTPO, WDM, WDS, BTO, and CCS certification shall be thirty-two (\$32.00) dollars regardless of the number of classifications held.

** The late fee for the WTPO, WDM, WDS, BTO, and CCS certification shall remain twenty-seven (\$27.00) dollars regardless of the number of classifications held.

1. A late fee shall be assessed to operators failing to submit the required fee within the time period specified on the renewal form.
2. The application fee for reciprocity shall be one hundred thirty-four dollars (\$134.00) per classification.
3. The application fee for automatic upgrade (WTPO-IT to WTPO 1 and/or WDM-IT to WDM 1) shall be sixty-six dollars (\$66.00).

Reciprocity With Other States

A certificate of competency may be issued, without examination, if the applicant holds a valid water works operator certification issued under the laws of any other state or province provided:

- The out-of-state education, operating experience, and professional growth requirements are equal to, or more stringent than the provisions of WAC 246-292;
- The applicant passed the appropriate Association of Boards of Certification (ABC) written exam with the equivalent passing score; and
- An application has been submitted with proof of a valid water works certification and the appropriate reciprocity fee.

An applicant who is denied reciprocity will be notified of certification options.

Application and Examination Process

Following is the basic procedure for a person seeking initial water works certification. It identifies applicant and DOH responsibilities.

1. A person seeking water works certification must submit to DOH, Water Works Operator Certification Program (Certification Program) the following:
 - ✓ DOH's **current** water works certification application, and supporting documents;
 - ✓ The appropriate application and examination fees;
 - ✓ When required by classification level applied for, all official or unaltered copies of college or other transcripts.
2. DOH schedules three examinations a year. Examinations are normally held on the first Tuesday of February, June, and October of each year.

There may be instances where examinations are scheduled for another day of the week due to exam room availability. If this occurs, the applicant is notified of the change of date.
3. Applications **must be postmarked to DOH, Water Works Operator Certification Program, no later than the application deadline date** listed on the application instructions.
4. Incomplete applications are returned and must be submitted and postmarked by the application deadline date. Applications postmarked after the application deadline date will be processed for the next available exam date.
5. Approximately one month prior to the exam, all applicants for examination will receive written confirmation from DOH identifying the approved exam, time, date, and location of the exam.
6. Exams will not be administered to individuals who appear for an exam without a written scheduling notice. In the event an individual takes an exam without proper authorization from the Certification Program, DOH will destroy the exam answer sheet before it is graded.
7. Examinations will be closed book. The examination formulas and conversion factors are provided in each operator examination packet. **See Appendices P & Q.**
8. Hand held numeric calculators are allowed. Text entry programmable calculators such as laptops, electronic organizers or equivalent may not be used.
9. All applicants for examination will be required to provide picture identification (i.e. driver license, military identification card, or other government issued identification) prior to taking the examination. Applicants who do not have picture identification must obtain approval from the Certification Program office two weeks in advance of the exam.
10. DOH will, in its discretion, conduct oral examinations instead of, or to augment, written examinations to comply with 42 U.S.C. 12101 -- 42 U.S.C. 12213 (Americans With Disabilities Act). To request an oral exam, the applicant must submit a letter citing the special circumstances as justification. The department may request additional justification as deemed necessary. If the department allows a special exam it shall set the time and place that in its discretion, are appropriate to address the needs of the applicant.
11. Examination subject information and study references can be found in **Appendices B through O**. DOH contracts with the Association of Boards of Certification (ABC) for the following exams: WDS, WDM, BTO, WTPO, and CCS.

Renewal Process

All certified water works operators are required to renew their certificates annually. Following is the renewal process:

1. The operator certificate must be renewed January 1 of each year.
2. DOH will mail the water works operator certification renewal notice to the *operator's home address*. It is the operator's responsibility to keep DOH informed of the current home mailing address. **Failure to notify DOH of a change of address does not constitute a reasonable excuse for failure to renew a certificate or failure to demonstrate professional growth. DOH will not consider appeals from operators who fail to notify the department of address changes.**
3. The initial renewal notice will be mailed in November. If payment has not been received by mid-January, a second and final renewal notice will be mailed.
4. A renewal late fee will be assessed to operators failing to submit the required renewal fee within the time period specified on the initial renewal notice.
5. The department will renew the operator certificate upon payment of the renewal fee and demonstration of professional growth acceptable to DOH within the designated professional growth reporting period. See **Professional Growth**, page 23.
6. The department will notify an operator failing to renew the operator certificate that the certificate is temporarily valid for two months beginning January 1.
7. A certificate not renewed during the two-month period will become invalid. The department will notify the holder of an invalid certificate with a written notice.
8. An operator failing to renew their certification under the provisions of WAC 246-292-090 may reapply for certification and must meet the requirements for a new applicant.

Professional Growth

The Water Works Operator Certification Program requires certified operators to demonstrate continued professional growth in the field in order to be eligible for certification renewal. Under the direction of the Department of Health, the Washington Environmental Training Center (WETRC) at Green River Community College provides course evaluation and Continuing Education Unit (CEU) assignment services to water works training course sponsors and maintains individual professional growth transcripts for each certified operator.

1. Professional Growth Requirement For Certified Water Works Operators

To meet the professional growth requirement, each certified water works operator must accomplish one of the following within the timetable listed below:

- Option 1:** Accumulate a minimum of three Continuing Education Units (CEU) or college credit for training that is directly relevant to the operation, maintenance or management of a water system; **and** have an influence on water quality, water supply, or public health protection.
- Option 2:** Advance by examination in the Water Works Operator Certification Program to a Level 2, 3 or 4, or achieve certification by examination in a different classification as follows:
- WDM to WTPO, BTO or CCS
 - WTPO to WDM or CCS
 - BTO to WDM, WTPO, WDS or CCS
 - WDS to WDM, WTPO, BTO or CCS
 - CCS to WDM , WTPO or WDS

The following timetable indicates when certified operators must meet the professional growth requirement:

If You Were Certified:	Then You Must Meet The Professional Growth Requirement Between:
Before 1/1/98	1/1/2001 and 12/31/2003 and in each 3-year reporting period thereafter.
1/1/98 - 12/31/2000	Your original certification date and 12/31/2003 and in each 3-year reporting period thereafter.
1/1/2001 - 12/31/2003	Your original certification date and 12/31/2006 and in each 3-year reporting period thereafter.

A. Recording and Reporting CEU

It is the certified operator's responsibility to satisfy the professional growth requirement on or before December 31 of the reporting year. This is accomplished through the following process:

- (1) DOH will notify WETRC of all certified operators who meet the professional growth requirement using Option 2 above.
- (2) The training sponsor or operator must submit verification of CEU or college credit earned to WETRC. Submittal forms may be requested from WETRC.
- (3) WETRC will evaluate all verification of CEU or college credit submitted based on criteria established by DOH and by the International Association of Continuing Education and Training (IACET). CEU or college credit meeting DOH and IACET criteria will be posted to the operator's professional growth transcript.

If an operator fails to satisfy the requirement by the deadline date, the operator's certificate will not be renewable. If an operator does satisfy the professional growth requirement using Option 1 on or before December 31 of the reporting year, but fails to provide documentation to WETRC, the operator's certificate will be temporarily valid for two months as required by WAC 246-292-090(6). Relevant CEU or college credit earned during the professional growth reporting period may be submitted to WETRC for consideration until **February 15th** of the period during which the operator holds a temporarily valid certificate. If the documentation submitted satisfies the professional growth requirement, DOH will provide notification that the operator's certificate is renewable.

When a certified operator satisfies the professional growth requirement, WETRC will provide the operator with a completion letter and a professional growth transcript. This letter is the only official record accepted by DOH as documentation of demonstrating continued professional growth in the field. WETRC will notify DOH that the operator has satisfactorily met the professional growth requirement.

DOH has directed WETRC to restrict record keeping to that required by a certified operator to meet the professional growth requirements specified by law. Therefore, when an operator has met the professional growth requirement for certification renewal for the current reporting period, documentation of additional training will not be accepted by WETRC for the remainder of that reporting period. Keeping track of training beyond that required for professional growth is the operator's responsibility.

CEU or college credit that is earned prior to the operator's certification date, CEU or college credit that have not been earned in the operator's current professional growth reporting period, and CEU less than 0.3 will not be recorded on the operator's transcript.

Certified operators who met the professional growth requirement by using CEU or college credit earned for successful completion or instruction of a course may repeat the same course in a different reporting period. CEU equal to **one-half** of the original course CEU assignment may be applied toward the professional growth requirement for the current reporting period. **No CEU** will be earned for courses repeated during the same reporting period, or for any repeated correspondence courses or distance learning activities.

B. CEU Assignment

DOH requires that CEU used to meet an operator's professional growth requirement for renewal be awarded by:

- (1) WETRC, or
- (2) A training course sponsor that awards CEU based on a formal evaluation and assignment process following the minimum guidelines established by IACET.

All requests for course evaluation and CEU assignment through WETRC must be submitted to WETRC by the course sponsor. **Requests received less than 15 calendar days prior to the scheduled training date will be returned to the sponsor without evaluation.** Requests for evaluation of multi-session conferences should be submitted at least 30 days in advance to allow adequate time for evaluation.

CEU assignments for courses evaluated by WETRC will be valid for three (3) years from the date of the original CEU assignment. The original assignment will be considered invalid within the three-year period if the course sponsor, title, content, or length changes; or if the course no longer meets current DOH evaluation criteria. At the end of the three-year period, course sponsors will be required to submit a new Request for CEU Evaluation packet.

All courses assigned CEU by WETRC will be issued an identification number. The course sponsor must refer to this identification number on the completed WETRC Participant Roster that is submitted at the conclusion of each training session, and on any other correspondence or inquiries regarding CEU assignment.

Each individual workshop, training session or education conference must provide a minimum of three contact hours of training in order to be eligible for CEU evaluation, assignment or recording. Therefore the minimum CEU assignment will be 0.3 CEUs.

If an operator earns CEU for completing training that has not been evaluated by WETRC, or earns college credit, the operator must submit a completed Training Submittal Form available from WETRC. Training curriculum and CEU assignment from the sponsor will be evaluated based on DOH and IACET criteria. Training that meets DOH and IACET criteria will be accepted toward the operator's professional growth requirement. Training that has not been assigned either CEU or college credit by the sponsor will not be evaluated.

Note: For information regarding the appeals process see page 29.

2. Professional Growth Requirement For Certified Backflow Assembly Testers

The Water Works Operator Certification regulation, WAC 246-292-090(4), requires the holder of a Backflow Assembly Tester (BAT) certification to demonstrate professional growth by passing the DOH's BAT professional growth examination during each reporting period. The Washington Environmental Training Center (WETRC) is responsible for proctoring the BAT professional growth examination and implementing the BAT professional growth program for DOH.

The following timetable indicates when certified Backflow Assembly Testers must meet the professional growth requirement:

If You Were Certified:	Then You Must Pass The Bat Professional Growth Examination Between:
Before 1/1/98	1/1/2001 and 12/31/2003 and in each 3-year reporting period thereafter.
1/1/98 - 12/31/2000	Your original certification date and 12/31/2003 and in each 3-year reporting period thereafter.
1/1/2001 - 12/31/2003	Your original certification date and 12/31/2006 and in each 3-year reporting period thereafter.

Backflow Assembly Tester Certification

The Department of Health (DOH) contracts with Green River Community College, Washington Environmental Training Center (WETRC) to administer the State's Backflow Assembly Tester (BAT) Certification Program. WETRC is responsible for the following activities:

- Scheduling and proctoring BAT certification and professional growth examinations following criteria established by DOH;
- Maintaining BAT certification and professional growth database and files;
- Issuing new BAT Certificates of Competency;
- Issuing BAT validation cards;
- Processing annual BAT renewal notices and payments;
- Tracking and monitoring compliance with the BAT professional growth requirement;
- Accepting and processing BAT address, name and other information changes;
- Responding to all telephone inquiries regarding BAT certification and professional growth requirements; and
- Initiating correspondence with and notification to BATs regarding certification and professional growth status.

Enforcement elements of the BAT program are administered by the Department of Health (see page 28 Revocation and Suspension).

Revocation and Suspension

Per chapter 246-292-100 WAC,

1. The department may suspend for a specified time or revoke an operator's certificate if the operator:
 - (a) Obtains a certificate by fraud or deceit;
 - (b) Demonstrates gross negligence in the operation of a purification plant or distribution system; or
 - (c) Intentionally violates the requirements of this chapter or any department rules or orders.
2. The department shall provide written notice of violation and reasonable opportunity for correction prior to taking action on revocation or suspension of an operator's certificate.
3. The department shall not initiate action to revoke a certificate until the department has conducted a hearing to consider the appropriateness of revocation.
4. A revocation or suspension action brought under this section shall be conducted in accordance with RCW 43.70.115, chapter 34.05 RCW, and chapter 246-10 WAC.
5. A person whose certificate is revoked is not eligible to apply for certification for one (1) year from the effective date of the final order of revocation.
6. A person whose certificate was revoked and who desires to apply for certification shall apply as a new operator in accordance with WAC 246-292-070.
7. An operator whose certificate is suspended shall continue to meet all renewal requirements in accordance with WAC 246-292-090 in order to maintain certification.

Note: Revocation and suspension criteria for violations by a certified operator are under further development. Contact the Certification Program office for updated information.

Appeals Process

Relevancy Review and Appeal Procedure

The WETRC Professional Growth Manager will review training submitted by the course sponsor for CEU evaluation and assignment, or training submitted by a certified operator that has already been awarded CEU by the course sponsor. Any training that does not meet the department's relevancy criteria will be denied and the Professional Growth Manager will notify the submitter in writing. The course sponsor or certified operator may appeal for a review of the Professional Growth Manager's denial by submitting a request in writing within thirty days of the date on the CEU denial letter to the Water Works Certification Program Manager. The following appeal procedure will be followed:

1. The Water Works Certification Program Manager will distribute the course information to the Professional Growth Relevancy Sub-Committee of the Water Works Operator Certification Advisory Committee for review and relevancy determination recommendation. The Sub-Committee will make its relevancy determination recommendation to the Water Works Certification Program Manager within fifteen days of receipt of the request.
2. Upon receipt of the Sub-Committee's recommendation, the Water Works Certification Program Manager will notify the Professional Growth Program Manager of the department's decision.
3. The Professional Growth Program Manager will notify the course sponsor or operator of the department's decision and appeal procedure within thirty days of receipt of the decision.

The WETRC Professional Growth Manager will refer any training that may require additional evaluation based on the department's relevancy criteria directly to the Department of Health, Water Works Certification Program Manager prior to denial by the WETRC Professional Growth Manager. All such requests for relevancy review submitted directly to Department of Health by the WETRC Professional Growth Program Manager will follow the procedure outlined above.

Appeal of Professional Growth Relevancy Sub-Committee Denials Appeal of Other Continuing Education Unit (CEU) Denials

Denials based on the decision of the Professional Growth Relevancy Sub-Committee, and denials by the WETRC Professional Growth Manager based on Department of Health's other Professional Growth Program guidelines, may be appealed using the following procedure:

1. The course sponsor or certified operator must file an appeal in writing with the Department of Health, Water Works Certification Program Manager within thirty days of the date on the CEU denial letter.
2. If the appeal is not filed within the thirty days, appeal rights are forfeited.
3. The appeal letter should include justification for the appeal.
4. Appeals will be reviewed by the Water Works Operator Certification Advisory Committee at its next available meeting. The committee will make its recommendation to the Department of Health, Water Works Certification Program Manager.
5. The Water Works Certification Program Manager will notify the course sponsor or certified operator and the Professional Growth Program Manager of the department's decision within thirty days of the Water Works Operator Certification Advisory Committee's determination.

Certification Renewal Appeals

In order to appeal a non-renewed certification the operator must file the appeal with the Department of Health, Water Works Certification Program Manager within sixty days of the date on the operator certification inactivation letter. If the appeal is not filed within the sixty days, appeal rights are forfeited.

For further information regarding appeals contact the Certification Program office.

Appendix A

Water Distribution Specialist (WDS)

Examination Information

This examination consists of 50 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P&Q*. Below is the exam description.

<u>Objectives</u>	<u># Item</u>	<u>Points</u>	<u>Short Description</u>
Blowers-Compressor/C	1	1	Blowers & Compressors-Math Chemical
Chemical Feeders/C	2	2	Feeders-Math
Compliance	6	6	Compliance
Disinfection	8	8	Disinfection
Finances/C	1	1	Finances-Math
Flow Measurement/C	1	1	Flow Measurement-Math
General Safety	7	7	General Safety
Hydraulics/C	2	2	Hydraulics-Math
Hydraulics	2	2	Hydraulics
Laboratory	5	5	Laboratory
Math/C	2	2	Math
Maintenance Mgmt	1	1	Maintenance Management
Public Health	2	2	Public Health Principles
Public Relations	1	1	Public Relations
Pumps	3	3	Pumps
QC-QA	1	1	Quality Control & Assurance
Safety Admin	1	1	Safety Administration
Science	2	2	Science
Storage	1	1	Storage
Wells	1	1	Well Operation

The passing score for these exams is 70%.

Study References

See Appendix F.

Appendix B

Water Distribution Manager (WDM) IT & 1

Examination Information

This examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

<u>Objectives</u>	<u>#Items</u>	<u>Points</u>	<u>Short Descriptions</u>
CCC & Backflow	2	2	CCC & Backflow
Chemical Feeders	1	1	Chemical Feeders
Chemical Feeders/C	1	1	Chemical Feeders-Math
Compliance	16	16	Compliance
Conveyance	7	7	Conveyance
Disinfection	12	12	Disinfection
Disinfection/C	1	1	Disinfection-Math
Drives	1	1	Drives
Electrical Controls	2	2	Electrical Controls
Finances	1	1	Finances
Fittings	2	2	Fittings
Flow Measurement/C	2	2	Flow Measurement-Math
Flushing	1	1	Flushing
General Safety	11	11	General Safety
Hydraulics	1	1	Hydraulics
Hydraulics/C	2	2	Hydraulics-Math
Information	1	1	Information
Laboratory	5	5	Laboratory
Maintenance Mgmt	2	2	Maintenance Management
Math/C	1	1	Math
Measuring-Control/C	1	1	Measuring & Control-Math
Public Health	3	3	Public Health Principles
Pumps	9	9	Pumps
Pumps/C	1	1	Pumps-Math
Public Relations	3	3	Public Relations
QC-QA	1	1	Quality Control & Assurance
Safety Admin	3	3	Safety Administration
Science	1	1	Science
Source & Character	1	1	Source & Characteristics
Storage	1	1	Storage
Storage/C	1	1	Storage-Math
System	1	1	System
Valves	1	1	Valves
Wells	1	1	Well Operation

Passing score for this exam is 70%.

Study References

See Appendix G

Appendix C

Water Distribution Manager (WDM) 2

Examination Information

This examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

<u>Objectives</u>	<u># Items</u>	<u>Points</u>	<u>Short Descriptions</u>
CCC & Backflow	2	2	CCC & Backflow
Chemical Feeders	1	1	Chemical Feeders
Compliance	7	7	Compliance
Conveyance	2	2	Conveyance
Corrosion Control	1	1	Corrosion Control
Disinfection	14	14	Disinfection
Disinfection/C	2	2	Disinfection-Math
Drives	3	3	Drives
Electrical Controls	3	3	Electrical Controls
Flow Measurements/C	1	1	Flow Measurement-Math
Fluoridation	1	1	Fluoridation
Flushing	1	1	Flushing
General Safety	8	8	General Safety
Hydraulics	1	1	Hydraulics
Hydraulics/C	1	1	Hydraulics-Math
Information	2	2	Information
Laboratory	10	10	Laboratory
Leak Detection/C	1	1	Leak Detection - Math
Maintenance Mgmt	2	2	Maintenance Management
Math/C	1	1	Math
Measuring & Control	1	1	Measuring & Control
Measuring & Control/C	1	1	Measuring & Control- - Math
Motors	1	1	Motors
Personnel	2	2	Personnel
Pipes/C	1	1	Pipes-Math
Pressure Control	1	1	Pressure Control
Public Health	4	4	Public Health Principles
Public Relations	1	1	Public Relations
Pumps	11	11	Pumps
Pumps/C	1	1	Pumps - Math
QC-QA	1	1	Quality Control & Assurance
Safety Admin	3	3	Safety Administration
Science	2	2	Science
Storage	1	1	Storage
Storage/C	1	1	Storage-Math
System	1	1	System
Trenching	1	1	Trenching
Wells	2	2	Well Operation

Passing score for this exam is 70%.

Study References

See Appendix G

Appendix D

Water Distribution Manager (WDM) 3

Examination Information

This examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

<u>Objectives</u>	<u># Items</u>	<u>Points</u>	<u>Short Descriptions</u>
CCC & Backflow	1	1	CCC & Backflow
Compliance	8	8	Compliance
Conveyance	6	6	Conveyance
Conveyance/C	1	1	Conveyance - Math
Corrosion Control	1	1	Corrosion Control
Disinfection	18	18	Disinfection
Disinfection/C	2	2	Disinfection – Math
Drives	1	1	Drives
Electrical Controls	2	2	Electrical Controls
Flushing	1	1	Flushing
General Safety	7	7	General Safety
Hydraulics	1	1	Hydraulics
Hydraulics/C	2	2	Hydraulics-Math
Information	1	1	Information
Joints	1	1	Joints
Laboratory	4	4	Laboratory
Laboratory/C	1	1	Laboratory – Math
Leak Detection/C	1	1	Leak Detection - Math
Maintenance Mgmt	2	2	Maintenance Management
Math/C	1	1	Math
Measuring & Control	1	1	Measuring & Control
Metering	1	1	Metering
Motors	1	1	Motors
Personnel	2	2	Personnel
Pipes	3	3	Pipes
Pipes/C	1	1	Pipes - Math
Pressure Control	1	1	Pressure Control
Public Health	10	10	Public Health Principles
Public Relations	3	3	Public Relations
Pumps	5	5	Pumps
Pumps/C	1	1	Pumps – Math
Safety Administration	1	1	Safety Administration
Science	1	1	Science
Storage	1	1	Storage
System	4	4	System
Trenching	2	2	Trenching

Passing score for this exam is 70%.

Study References

See Appendix G

Appendix E

Water Distribution Manager (WDM) 4

Examination Information

This examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

<u>Objectives</u>	<u># Items</u>	<u>Points</u>	<u>Short Description</u>
CCC & Backflow	3	3	CCC & Backflow
Chemical Feeders	1	1	Chemical Feeders
Chemical Feeders/C	3	3	Chemical Feeders-Math
Compliance	7	7	Compliance
Conveyance	8	8	Conveyance
Corrosion Control	2	2	Corrosion Control
Disinfection	5	5	Disinfection
Drives	2	2	Drives
Electrical Controls	5	5	Electrical Control
Finances	3	3	Finances
Fluoridation/C	1	1	Fluoridation-Math
General Safety	4	4	General Safety
Hydraulics/C	2	2	Hydraulics-Math
Information	1	1	Information
Laboratory	4	4	Laboratory
Laboratory/C	1	1	Laboratory-Math
Leak Detect-Repair	2	2	Leak Detection & Repair
Maintenance Mgmt	3	3	Maintenance Management
Measuring & Control	4	4	Measuring & Control
Metering	1	1	Metering
Motors	1	1	Motors
Motors/C	3	1	Motors-Math
Personnel	9	9	Personnel
Pipes	4	4	Pipes
Pressure Control	2	2	Pressure Control
Public Health	5	5	Public Health Principles
Public Relations	1	1	Public Relations
Pumps	3	3	Pumps
Pumps/C	1	1	Pumps-Math
QC-QA	1	1	Quality Control & Assurance
Science	2	2	Science
Sources & Charc/C	1	1	Sources & Characteristics-Math
Sources & Character	1	1	Sources & Characteristics
Storage	1	1	Storage
Trenching	1	1	Trenching
Valves	2	2	Valves

The passing score for this exam is 70%.

Study References

See Appendix G

Appendix F

Water Distribution Specialist

California State University (Ken Kerri) Text Book Examination References

Exam Objective	Reference Manual
Blowers & Compressors	Water Treatment Plant Operation, Vol. II, Ch. 18
CCC & Backflow	Water Distribution System Operation and Maintenance, Ch. 5
Chemical Feeders	Water Treatment Plant Operation, Vol. II, Ch. 14
Compliance	Water Treatment Plant Operation, Vol. II, Ch. 22 Small Water System Operation and Maintenance, Ch. 2
Conveyance	Water Distribution System Operation and Maintenance, Ch. 3 and 5
Corrosion Control	Water Treatment Plant Operation, Vol. I, Ch. 8
Disinfection	Small Water System Operation & Maintenance, Ch. 7 Water Treatment Plant Operation, Vol. I, Ch. 7
Drives	Water Treatment Plant Operation Vol. II, Ch. 18
Electrical Controls	Water Treatment Plant Operation, Vol. II, Ch. 18 and 19
Electricity	Water Treatment Plant Operation, Vol. II, Ch. 18
Emergency Response	Water Treatment Plant Operation, Vol. I, Ch. 10
Finances	Water Treatment Plant Operation, Vol. II, Ch. 18 and 23
Flow Measurement	Small Water System Operation and Maintenance, Appendix
Flushing	Water Distribution System Operation and Maintenance, Ch. 5
General Safety	Small Water System Operation and Maintenance, Ch. 6 Water Treatment Plant Operation, Vol. II, Ch. 20
Hydrants	Water Distribution System Operation and Maintenance, Ch. 3 and 5
Hydraulics	Small Water System Operation and Maintenance, Ch. 3 and Appendix
Information	Water Treatment Plant Operation, Vol. II, Ch. 23
Laboratory	Water Treatment Plant Operation, Vol. I, Ch.11
Maintenance Management	Water Treatment Plant Operation, Vol. II, Ch. 18 and 23
Maps & Plans	Water Treatment Plant Operation, Vol. II, Ch. 18
Math	Small Water System Operation and Maintenance, Appendix Water Treatment Plant Operation, Vol. I, Appendix
Measuring & Control	Water Treatment Plant Operation, Vol. I, Appendix
Metering	Water Distribution System Operation and Maintenance, Ch. 3
Motors	Water Treatment Plant Operation, Vol. II, Ch. 18
Pipes	Water Treatment Plant Operation, Vol. II, Ch. 18
Planning	Water Treatment Plant Operation, Vol. II, Ch. 23
Pressure Control	Water Distribution System Operation and Maintenance, Ch. 3 and 5
Public Health Principles	Small Water System Operation and Maintenance, Ch. 2
Public Relations	Water Treatment Plant Operation, Vol. II, Ch. 23
Pumps	Water Treatment Plant Operation, Vol. II, Ch. 18
Quality Control & Assurance	Water Treatment Plant Operation, Vol. I, Ch. 10
Safety Administration	Water Treatment Plant Operation, Vol. II, Ch. 20 and 23

Science	Water Treatment Plant Operation, Vol. I, Ch. 7 and Vol. II, Ch. 11
Sources & Characteristics	Small Water System Operation and Maintenance, Ch. 2 Water Treatment Plant Operation, Vol. I, Ch. 2
Storage	Water Distribution System Operation and Maintenance, Ch. 2
Taste & Odor Control	Water Treatment Plant Operation, Vol. I, Ch. 9
Units of Expression	Water Treatment Plant Operation, Vol. I, Appendix
Valves	Water Treatment Plant Operation, Vol. II, Ch. 18
Well Operation	Small Water System Operation and Maintenance, Ch. 3

Water Distribution Specialist AWWA Bookstore Examination References

Exam Objective	Reference Material
Blowers & Compressors	Water Treatment, Ch. 14
CCC & Backflow	Water Transmission and Distribution, Ch. 11
Chemical Feeders	Basic Science Concepts and Applications, Chemistry 4 and 7
Compliance	Water Quality, Ch. 1 and 4
Conveyance	Water Transmission and Distribution, Ch. 6 and 9
Corrosion Control	Water Treatment, Ch. 9
Disinfection	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment, Ch. 7
Drives	Water Transmission and Distribution, Ch. 12 and 13
Electrical Controls	Water Transmission and Distribution, Ch. 13
Electricity	Basic Science Concepts and Applications, Electricity 2 Water Transmission and Distribution, Ch. 13
Emergency Response	Emergency Planning for Water Utility Management
Finances	Maintenance Management for Water Utilities
Fittings	Water Transmission and Distribution, Ch. 4 and 9
Flow Measurement	Basic Science Concepts and Applications, Hydraulics 7 and Mathematics 11 and 16
Flushing	Water Transmission and Distribution, Ch. 8
General Safety	No reference source specified
Hydrants	Water Transmission and Distribution, Ch. 6
Hydraulics	Basic Science Concepts and Applications, Hydraulics 2, 4, 6 and Mathematics 10
Information	Water Transmission and Distribution, Ch. 15
Laboratory	Water Quality, Ch. 2 - 6
Maintenance Management	Water Transmission and Distribution, Ch. 15
Maps & Plans	Water Transmission and Distribution, Ch. 15
Math	Basic Science Concepts and Applications, Chemistry 4 and 7 Basic Science Concepts and Applications, Hydraulics 2, 6 Basic Science Concepts and Applications, Mathematics 9 - 11, 16, 22, 23

Measuring & Control	Basic Science Concepts and Applications, Mathematics 16 Water Transmission and Distribution, Ch. 10 and 14
Metering	Water Transmission and Distribution, Ch. 10
Motors	Water Transmission and Distribution, Ch. 13
Pipes	Basic Science Concepts and Applications, Mathematics 10 Water Transmission and Distribution, Ch. 1, 2, 5 and 8
Planning	Maintenance Management for Water Utilities
Pressure Control	Water Transmission and Distribution, Ch. 11 and 12
Public Health Principles	Water Quality, Ch. 1 and 4
Public Relations	Water Transmission and Distribution, Ch. 16
Pumps	Basic Science Concepts and Applications, Hydraulics 6 Water Transmission and Distribution, Ch. 12
Quality Control & Assurance	Water Quality, Ch. 9 Water Transmission and Distribution, Ch. 10
Safety Administration	No reference source specified
Science	Basic Science Concepts and Applications, Chemistry 5 and 6
Sources & Characteristics	Water Sources, Ch.1 and 6
Storage	Basic Science Concepts and Applications, Hydraulics 2 and Mathematics 22 Water Transmission and Distribution, Ch. 7
Taste & Odor Control	Water Treatment, Ch. 7
Units of Expression	Basic Science Concepts and Applications, Mathematics 11
Valves	Water Transmission and Distribution, Ch. 3
Well Operation	Basic Science Concepts and Applications, Mathematics 23 Water Sources, Ch. 1 and 2

Appendix G

Water Distribution Manager

California State University (Ken Kerri) Text Book Examination References

Exam Category	Reference Manual
Batteries	Water Treatment Plant Operation, Vol. II, Chapter 18
Blowers & Compressors	Water Treatment Plant Operation, Vol. II, Chapter 18
Cathodic Protection Devices	Water Distribution System O & M, Chapters 2 and 3
CCC & Backflow	Water Distribution System O & M, Chapter 5
Chemical Feeders	Water Distribution System O & M, Chapter 6
Chlorination	Water Distribution System O & M, Chapter 6
Compliance	Water Treatment Plant Operation, Vol. II, Chapter 22
Conveyance	Water Distribution System O & M, Chapter 5
Corrosion Control	Water Distribution System O & M, Chapters 2 & 3
Drives	Water Treatment Plant Operation, Vol. II, Chapter 18
Electrical Controls	Water Treatment Plant Operation, Vol. II, Chapter 18
Electricity	Water Treatment Plant Operation, Vol. II, Chapter 18
Emergency Response	Water Treatment Plant Operation, Vol. II, Chapter 23
Engines	Water Treatment Plant Operation, Vol. II, Chapter 18
Finances	Water Treatment Plant Operation, Vol. II, Chapter 23
Fittings	Water Distribution System O & M, Chapter 3
Flow Management	Water Treatment Plant Operation, Vol. II, Chapter 19
Fluoridation	Water Treatment Plant Operation, Vol. II, Chapter 13
Flushing Systems	Water Distribution System O & M, Chapter 5
General Safety	Water Distribution System O & M, Chapter 7
Generators	Water Treatment Plant Operation, Vol. II, Chapter 18
HVAC	Water Treatment Plant Operation, Vol. II, Chapter 18
Hydrants	Water Distribution System O & M, Chapter 3
Hydraulics	Water Distribution System O & M, Appendix
Information	Water Treatment Plant Operation, Vol. II, Chapter 23
Joints	Water Distribution System O & M, Chapter 3
Laboratory	Water Treatment Plant Operation, Vol. I, Chapter 11, & Vol. II, Chapter 21
Leak Detection & Repair	Water Distribution System O & M, Chapter 5
Maintenance Management	Water Treatment Plant Operation, Vol. II, Chapter 23
Maps & Plans	Water Distribution System O & M, Chapter 5
Math	Water Distribution System O & M, Appendix
Measuring & Control Systems	Water Treatment Plant Operation, Vol. II, Chapter 19
Metering	Water Distribution System O & M, Chapter 3
Motors	Water Treatment Plant Operation, Vol. II, Chapter 18
Personnel	Water Treatment Plant Operation, Vol. II, Chapter 23
Pipes	Water Distribution System O & M, Chapter 3
Planning	Water Treatment Plant Operation, Vol. II, Chapter 23
Pressure Control	Water Distribution System O & M, Chapter 5
Public Health Principles	Water Treatment Plant Operation, Vol. I, Chapter 2
Public Relations	Water Treatment Plant Operation, Vol. II, Chapter 23
Pumps	Water Distribution System O & M, Chapter 5 Water Treatment Plant Operation, Vol. II, Chapter 18
Quality Control & Assurance	Water Distribution System O & M, Chapter 5

Rolling Stock	Water Treatment Plant Operation, Vol. II, Chapter 18
Safety Administration	Water Distribution System O & M, Chapter 7
Safety Equipment	Water Distribution System O & M, Chapter 7
Science	Water Distribution System O & M, Appendix
Security	Water Treatment Plant Operation, Vol. II, Chapter 23
Sources & Characteristics	Water Treatment Plant Operation, Vol. I, Chapter 2
Storage	Water Distribution System O & M, Chapter 2
Transformers	Water Treatment Plant Operation, Vol. II, Chapter 18
Units of Expression	Water Distribution System O & M, Appendix
Valves	Water Distribution System O & M, Chapters 3 & 5
Well Operation	Small Water System O & M, Chapter 3

Water Distribution Manager AWWA Bookstore Examination References

Exam Objective	Reference Material
Blowers & Compressors	Water Treatment, Ch. 14
Cathodic Protection Devices	Water Transmission and Distribution, Ch. 8
CCC & Backflow	Water Transmission and Distribution, Ch. 11
Chemical Addition	Basic Science Concepts and Applications, Chemistry 4 and 7
Chemical Feeders	Basic Science Concepts and Applications, Chemistry 4 and 7
Compliance	Water Quality, Ch. 1 and 4
Conveyance	Water Transmission and Distribution, Ch. 3, 4, 5, 6, 9
Corrosion Control	Basic Science Concepts and Applications, Chemistry 6 Water Transmission and Distribution, Ch. 8 Water Treatment, Ch. 9
Disinfection	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment Ch. 7
Drives	Water Transmission and Distribution, Ch. 12 and 13
Electrical Controls	Basic Science Concepts and Applications, Electricity 1 Water Transmission and Distribution, Ch. 13
Electricity	Basic Science Concepts and Applications, Electricity 2 Water Transmission and Distribution, Ch. 13
Emergency Response	Emergency Planning for Water Utility Management
Engines	Water Transmission and Distribution, Ch. 13
Finances	Maintenance Management for Water Utilities
Fittings	Water Transmission and Distribution, Ch. 4 and 9
Flow Measurement	Basic Science Concepts and Applications, Mathematics 11 and 16 and Hydraulics 7
Fluoridation	Basic Science Concepts and Applications, Chemistry 7 Water Treatment, Ch. 8
Flushing	Water Transmission and Distribution, Ch. 8
General Safety	No reference source specified
Hydrants	Water Transmission and Distribution, Ch. 6

Hydraulics	Basic Science Concepts and Applications, Hydraulics 2 - 6 and Mathematics 10
Information	Water Transmission and Distribution, Ch. 15
Iron & Manganese Removal	Water Treatment, Ch. 10
Joints	Water Transmission and Distribution, Ch. 2
Laboratory	Water Quality, Ch. 2-6
Leak Detection & Repair	Water Transmission and Distribution, Ch. 8
Maintenance Management	Water Transmission and Distribution, Ch. 12 and 15
Maps & Plans	Water Transmission and Distribution, Ch. 15
Math	Basic Science Concepts and Applications, Chemistry 4 and 7 Basic Science Concepts and Applications, Hydraulics 1- 8 Basic Science Concepts and Applications, Mathematics 9 - 11, 16, 22 and 23
Measuring & Control	Basic Science Concepts and Applications, Mathematics 16 Water Transmission and Distribution, Ch. 10 and 14
Metering	Water Transmission and Distribution, Ch. 10
Motors	Basic Science Concepts and Applications, Hydraulics 6 Water Transmission and Distribution, Ch. 13
Personnel	Maintenance Management for Water Utilities
Pipes	Basic Science Concepts and Applications, Hydraulics 5 and Mathematics 10 Water Transmission and Distribution, Ch. 1, 2, 5 and 8
Planning	Maintenance Management for Water Utilities
Pressure Control	Water Transmission and Distribution, Ch. 11 and 12
Public Health Principles	Water Quality, Ch. 1 and 4
Public Relations	Water Transmission and Distribution, Ch. 16
Pumps	Basic Science Concepts and Applications, Hydraulics 6 Water Transmission and Distribution, Ch. 12
Quality Control & Assurance	Water Quality, Ch. 9 Water Transmission and Distribution, Ch. 10
Reports	No reference source specified
Safety Administration	No reference source specified
Science	Basic Science Concepts and Applications, Chemistry 2, 5 and 6
Sources & Characteristics	Water Sources, Ch. 1-3 and 6
Storage	Basic Science Concepts and Applications, Hydraulics 2 and Mathematics 22 Water Transmission and Distribution, Ch. 7
System	Water Transmission and Distribution, Ch. 1 and 8
Taste & Odor Control	Basic Science Concepts and Applications, Chemistry 7 Water Treatment, Ch. 7
Trenching	Water Transmission and Distribution, Ch. 4
Units of Expression	Basic Science Concepts and Applications, Chemistry 7 and Mathematics 11
Valves	Water Transmission and Distribution, Ch. 3
Well Operation	Basic Science Concepts and Applications, Mathematics 6 and 23 Water Sources, Ch. 1 and 2

Appendix H

Basic Treatment Operator (BTO)

Examination Information

The questions on this examination are all multiple choice. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*.

<u>Objective</u>	<u># Item</u>	<u>Points</u>	<u>Short Descriptions</u>
Chemical Feeders	1	1	Chemical Feeders
Compliance	6	6	Compliance
Disinfection	4	4	Disinfection
Electrical Controls	1	1	Electrical Controls
Emergency Response	2	2	Emergency Response
Filtration	13	13	Filtration
Finances	1	1	Finances
Flow Measurement	1	1	Flow Measurement
Flow Measurement/C	1	1	Flow Measurement-Math
General Safety	5	5	General Safety
Hydraulics	2	2	Hydraulics
Laboratory	5	5	Laboratory
Maintenance Mgmt	2	2	Maintenance Management
Math/C	6	6	Math
Measuring & Control	1	1	Measuring & Control
Metering	3	3	Metering
Public Relations	3	3	Public Relations
Pumps	4	4	Pumps
Pumps/C	1	1	Pumps-Math
QC-QA	1	1	Quality Control & Assurance
Regulations	8	8	Regulations
Safety Admin	1	1	Safety Administration
Source & Character	2	2	Source & Characteristics
Valves	1	1	Valves

The passing score for this exam is 70%.

Study References

See Appendix M.

Appendix I

Water Treatment Plant Operator (WTPO) IT & 1

Examination Information

This examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

<u>Objectives</u>	<u># Items</u>	<u>Points</u>	<u>Short Descriptions</u>
Blower-Compressor/C	1	1	Blowers & Compressors
Chemical Feeders	1	1	Chemical Feeders
Compliance	7	7	Compliance
Corrosion Control	1	1	Corrosion Control
Disinfection	9	9	Disinfection
Disinfection/C	3	3	Disinfection-Math
Drives	1	1	Drives
Electrical Controls	1	1	Electrical Controls
Finances	1	1	Finances
Flow Measurement/C	2	2	Flow Measurement-Math
General Safety	14	14	General Safety
Hydraulics	4	4	Hydraulics
Hydraulics/C	1	1	Hydraulics-Math
Information	4	4	Information
Laboratory	9	9	Laboratory
Laboratory/C	1	1	Laboratory - Math
Maintenance Mgmt	4	4	Maintenance Management
Math/C	1	1	Math
Measuring & Control	2	2	Measuring & Control
pH Adjustment	1	1	pH Adjustment
Public Health	2	2	Public Health Principles
Public Relations	1	1	Public Relations
Pumps	7	7	Pumps
Pumps/C	1	1	Pumps-Math
QC-QA	2	2	Quality Control & Assurance
Recordkeeping	1	1	Recordkeeping
Safety Admin	3	3	Safety Administration
Science	4	4	Science
Sources & Character	1	1	Sources & Characteristics
Storage	1	1	Storage
Valves	5	5	Valves
Wells	3	3	Well Operation
Wells/C	1	1	Well Operation-Math

The passing score for this exam is 70%.

Study References

See Appendix M

Appendix J

Water Treatment Plant Operator (WTPO) 2

Examination Information

This examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

<u>Objectives</u>	<u># Items</u>	<u>Points</u>	<u>Short Description</u>
Aeration	1	1	Aeration
Blowers & Compressors	1	1	Blowers & Compressors
Chemical Feeders	2	2	Chemical Feeders
Chemical Feeders/C	1	1	Chemical Feeders-Math
Compliance	3	3	Compliance
Disinfection	19	19	Disinfection
Disinfection/C	3	3	Disinfection-Math
Drives	4	4	Drives
Electrical Controls	1	1	Electrical Controls
Flow Measurement/C	1	1	Flow Measurement-Math
Fluoridation	2	2	Fluoridation
General Safety	8	8	General Safety
Hydraulics/C	2	2	Hydraulics-Math
Information	3	3	Information
Ion Exchange	2	2	Ion Exchange
Laboratory	9	9	Laboratory
Laboratory/C	1	1	Laboratory - Math
Maintenance Mgmt	2	2	Maintenance Management
Measuring & Control	3	3	Measuring & Control
Personnel	3	3	Personnel
Public Health	5	5	Public Health Principles
Public Relations	3	3	Public Relations
Pumps	9	9	Pumps
Science	6	6	Science
Sources & Character	2	2	Sources & Characteristics
Storage/C	1	1	Storage - Math
Units/C	1	1	Units of Expression - Math
Valves	2	2	Valves

The passing score for this exam is 70%.

Study References

See Appendix M

Appendix K

Water Treatment Plant Operator (WTPO) 3

Examination Information

This examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

<u>Objectives</u>	<u># Items</u>	<u>Points</u>	<u>Short Descriptions</u>
Aeration	1	1	Aeration
Blowers-Compressors	1	1	Blowers & Compressors
CCC & Backflow	1	1	CCC & Backflow
Chemical Feeders	1	1	Chemical Feeders
Chemical Feeders/C	1	1	Chemical Feeders-Math
Clarification	4	4	Clarification
Clarification/C	2	2	Clarification - Math
Coag-Floc	4	4	Coagulation & Flocculation
Compliance	10	10	Compliance
Corrosion Control	3	3	Corrosion Control
Disinfection	12	12	Disinfection
Disinfection/C	1	1	Disinfection - Math
Drives	2	2	Drives
Electrical Controls	3	3	Electrical Controls
Electricity	1	1	Electricity
Filtration	5	5	Filtration
Filtration/C	1	1	Filtration-Math
Finances/C	1	1	Finances - Math
Fluoridation	2	2	Fluoridation
Fluoridation/C	1	1	Fluoridation - Math
General Safety	7	7	General Safety
Information	1	1	Information
Laboratory	2	2	Laboratory
Maintenance Mgmt	3	3	Maintenance Management
Math/C	1	1	Math
Measuring & Control	2	2	Measuring & Control
Metering	1	1	Metering
Personnel	4	4	Personnel
Planning/C	1	1	Planning - Math
Public Health	4	4	Public Health Principles
Pumps	3	3	Pumps
Pumps/C	1	1	Pumps - Math
QC-QA	1	1	Quality Control & Assurance
Safety Admin	2	2	Safety Administration
Science	4	4	Science
Sources & Character	3	3	Sources & Characteristics
Storage	1	1	Storage
Taste & Odor	2	2	Taste & Odor Control

The passing score for this exam is 70%

Study References See Appendix M

Appendix L

Water Treatment Plant Operator (WTPO) 4

Examination Information

This examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

<u>Objectives</u>	<u># Items</u>	<u>Points</u>	<u>Short Descriptions</u>
Aeration	1	1	Aeration
Chemical Addition	1	1	Chemical Addition
Chemical Feeders	3	3	Chemical Feeders
Chemical Feeders/C	1	1	Chemical Feeders - Math
Clarification	3	3	Clarification
Clarification/C	1	1	Clarification -Math
Coag-Floc	9	9	Coagulation & Flocculation
Coag-Floc/C	1	1	Coagulation & Flocculation – Math
Compliance	7	7	Compliance
Corrosion Control	4	4	Corrosion Control
Corrosion Control	1	1	Corrosion Control - Math
Disinfection	8	8	Disinfection
Disinfection/C	2	2	Disinfection-Math
Electrical Controls	1	1	Electrical Controls
Electricity	1	1	Electricity
Filtration	3	3	Filtration
Filtration/C	1	1	Filtration-Math
Finances	1	1	Finances
Flow Measurement	1	1	Flow Measurement
Fluoridation	1	1	Fluoridation
General Safety	7	7	General Safety
Hydraulics/C	1	1	Hydraulics - Math
Laboratory	5	5	Laboratory
Maintenance Mgmt	3	3	Maintenance Management
Measuring & Control	1	1	Measuring & Control
Personnel	8	8	Personnel
Ph Adjustment	1	1	pH Adjustment
Pipes	1	1	Pipes
Pipes/C	1	1	Pipes-Math
Public Health	1	1	Public Health Principles
Public Relations	2	2	Public Relations
Pumps	4	4	Pumps
QC-QA	2	2	Quality Control & Assurance
Science	3	3	Science
Sludge Conditioning	2	2	Sludge Conditioning
Sludge Drying Beds	3	3	Sludge Drying Beds
Sludge Vacuum Filt	1	1	Sludge Vacuum Filters
Sources & Character	1	1	Sources & Characteristics
Storage/C	1	1	Storage - Math
Valves	1	1	Valves

The passing score for this exam is 70%.

Study References See Appendix M.

Appendix M

WATER TREATMENT PLANT OPERATOR BASIC TREATMENT OPERATOR

California State University (Ken Kerri) Text Book Examination References

Exam Category	Reference Manual
Aeration	Water Treatment Plant Operation, Vol. I, Chapter 9
Batteries	Water Treatment Plant Operation, Vol. II, Chapter 18
Blowers & Compressors	Water Treatment Plant Operation, Vol. II, Chapter 18
Cathodic Protection Devices	Water Treatment Plant Operation, Vol. I, Chapter 8
CCC & Backflow	Water Distribution System O & M, Chapter 5
Chemical Feeders	Water Treatment Plant Operation, Vol. II, Chapter 13
Chemical Precipitation Softening	Water Treatment Plant Operation Vol. II, Chapter 14
Clarification	Water Treatment Plant Operation, Vol. I, Chapter 5
Coagulation & Flocculation	Water Treatment Plant Operation, Vol. II, Chapter 4
Compliance	Water Treatment Plant Operation, Vol. II, Chapter 22
Corrosion Control	Water Treatment Plant Operation, Vol. I, Chapter 8
Dechlorination	Water Treatment Plant Operation, Vol. II, Chapter 16
Defluoridation	Water Treatment Plant Operation, Vol. II, Chapter 16
Demineralization	Water Treatment Plant Operation, Vol. II, Chapter 16
Desalinization	Water Treatment Plant Operation, Vol. II, Chapter 16
Disinfection	Water Treatment Plant Operation, Vol. I, Chapter 7
Drives	Water Treatment Plant Operation, Vol. II, Chapter 18
Electrical Controls	Water Treatment Plant Operation, Vol. II, Chapter 19
Electricity	Water Treatment Plant Operation, Vol. II, Chapter 18
Electrodialysis	Water Treatment Plant Operation, Vol. II, Chapter 16
Emergency Response	Water Treatment Plant Operation, Vol. II, Chapter 23
Engines	Water Treatment Plant Operation, Vol. II, Chapter 18
Filtration	Water Treatment Plant Operation, Vol. I, Chapter 6
Finances	Water Treatment Plant Operation, Vol. II, Chapter 23
Fittings	Water Treatment Plant Operation, Vol. II, Chapter 18
Flow Management	Water Treatment Plant Operation, Vol. II, Chapter 19
Fluoridation	Water Treatment Plant Operation, Vol. II, Chapter 13
General Safety	Water Treatment Plant Operation, Vol. II, Chapter 20
Generators	Water Treatment Plant Operation, Vol. II, Chapter 18
HVAC	Water Treatment Plant Operation, Vol. II, Chapter 18
Hydrants	Water Distribution System O & M, Chapter 3
Hydraulics	Water Treatment Plant Operation, Vol. I and II, Appendix
Information	Water Treatment Plant Operation, Vol. II, Chapter 23
Ion Exchange	Water Treatment Plant Operation, Vol. II, Chapter 14
Iron & Manganese Removal	Water Treatment Plant Operation, Vol. II, Chapter 12
Joints	Water Treatment Plant Operation, Vol. II, Chapter 18

Exam Category	Reference Manual
Laboratory	Water Treatment Plant Operation, Vol. I, Ch 11, Vol II, Ch 21
Land Application	Water Treatment Plant Operation, Vol. II, Chapter 17
Landfill Solids	Water Treatment Plant Operation, Vol. II, Chapter 17
Maintenance Management	Water Treatment Plant Operation, Vol. II, Chapter 23
Maps & Plans	Water Treatment Plant Operation, Vol. II, Chapter 23
Math	Water Treatment Plant Operation, Vol. I and II, Appendix
Measuring & Control Systems	Water Treatment Plant Operation, Vol. II, Chapter 19
Microscreens	Water Treatment Plant Operation, Vol. I, Chapter 3
Motors	Water Treatment Plant Operation, Vol. II, Chapter 18
Personnel	Water Treatment Plant Operation, Vol. II, Chapter 23
Pipes	Water Treatment Plant Operation, Vol. II, Chapter 18
Planning	Water Treatment Plant Operation, Vol. II, Chapter 23
Public Health Principles	Water Treatment Plant Operation, Vol. I, Chapter 2
Public Relations	Water Treatment Plant Operation, Vol. II, Chapter 23
Pumps	Water Treatment Plant Operation, Vol. II, Chapter 18
Quality Control & Assurance	Water Treatment Plant Operation, Vol. II, Chapter 10
Recirculation	Water Treatment Plant Operation, Vol. I, Chapter 3
Reverse Osmosis	Water Treatment Plant Operation, Vol. II, Chapter 16
Rolling Stock	Water Treatment Plant Operation, Vol. II, Chapter 18
Safety Administration	Water Treatment Plant Operation, Vol. II, Chapter 23
Safety Equipment	Water Treatment Plant Operation, Vol. II, Chapter 20
Science	Water Treatment Plant Operation, Vol. I and II, Appendix
Screening	Water Treatment Plant Operation, Vol. I, Chapter 3
Security	Water Treatment Plant Operation, Vol. II, Chapter 23
Sludge Belt Press	Water Treatment Plant Operation, Vol. II, Chapter 17
Sludge Centrifuges	Water Treatment Plant Operation, Vol. II, Chapter 17
Sludge Drying Beds	Water Treatment Plant Operation, Vol. II, Chapter 17
Sludge Filter Press	Water Treatment Plant Operation, Vol. II, Chapter 17
Sludge Vacuum Filters	Water Treatment Plant Operation, Vol. II, Chapter 17
Sources & Characteristics	Water Treatment Plant Operation, Vol. I, Chapter 2
Storage	Water Distribution System O & M, Chapter 2
Taste & Odor Control	Water Treatment Plant Operation, Vol. I, Chapter 9
Transformers	Water Treatment Plant Operation, Vol. II, Chapter 18
Units of Expression	Water Treatment Plant Operation, Vol. I and II, Appendix
Valves	Water Treatment Plant Operation, Vol. II, Chapter 18
Well Operation	Small Water System O & M, Chapter 3

Water Treatment Plant Operator

Basic Treatment Operator

AWWA Bookstore Examination References

Exam Objective	Reference Material
Adsorption	Water Treatment, Ch. 13
Aeration	Water Treatment, Ch. 14
Blowers & Compressors	Water Treatment, Ch. 14
Cathodic Protection Devices	Water Transmission and Distribution, Ch. 8
CCC & Backflow	Water Transmission and Distribution, Ch. 11
Chemical Pretreatment	Water Treatment, Ch. 14
Chemical Addition	Basic Science Concepts and Applications, Chemistry 4 and 7 Water Treatment, Ch. 7 and 11
Chemical Feeders	Basic Science Concepts and Applications, Chemistry 4 and 7 Water Treatment, Ch. 7 and 11
Clarification	Basic Science Concepts and Applications, Mathematics 10 and 17 - 22 Water Treatment, Ch. 3 and 5
Coagulation & Flocculation	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment, Ch. 4
Compliance	Water Quality, Ch. 1 and 4
Corrosion Control	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment, Ch. 9
Disinfection	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment, Ch. 7
Drives	Water Transmission and Distribution, Ch. 12 and 13
Electrical Controls	Basic Science Concepts and Applications, Electricity 1 Water Transmission and Distribution, Ch. 13
Electricity	Basic Science Concepts and Applications, Electricity 2 Water Transmission and Distribution, Ch. 13
Emergency Response	Emergency Planning for Water Utility Management
Engines	Water Transmission and Distribution, Ch. 13
Filtration	Basic Science Concepts and Applications, Mathematics 19 and 20 Water Treatment, Ch. 6
Finances	Maintenance Management for Water Utilities
Flow Measurement	Basic Science Concepts and Applications, Hydraulics 7 and Mathematics 11 and 16
Fluoridation	Basic Science Concepts and Applications, Chemistry 7 Water Treatment, Ch. 8
General Safety	No reference source specified
Hydrants	Water Transmission and Distribution, Ch. 6
Hydraulics	Basic Science Concepts and Applications, Hydraulics 2 - 6 and Mathematics 10
Information	Water Transmission and Distribution, Ch. 15

Ion Exchange	Basic Science Concepts and Applications, Chemistry 7
	Water Treatment, Ch. 12
Iron & Manganese Removal	Water Treatment, Ch. 10
Joints	Water Transmission and Distribution, Ch. 2
Laboratory	Basic Science Concepts and Applications, Chemistry 4 - 7
	Water Quality, Ch. 1-6
Leak Detection & Repair	Water Transmission and Distribution, Ch. 8
Maintenance Management	Water Transmission and Distribution, Ch. 12 and 15
Maps & Plans	Water Transmission and Distribution, Ch. 15
Math	Basic Science Concepts and Applications, Chemistry 4 and 7
	Basic Science Concepts and Applications, Hydraulics 1 - 8
	Basic Science Concepts and Applications, Mathematics 9 - 23
Measuring & Control	Basic Science Concepts and Applications, Mathematics 16
	Water Transmission and Distribution, Ch. 10 and 14
Metering	Water Transmission and Distribution, Ch. 10
Microscreens	Water Treatment, Ch. 3
Motors	Water Transmission and Distribution, Ch. 13
Personnel	Maintenance Management for Water Utilities
pH Adjustment	Water Treatment, Ch. 4
Pipes	Water Transmission and Distribution, Ch. 1 and 4
	Basic Science Concepts and Applications, Hydraulics 5 and Mathematics 10
Planning	Maintenance Management for Water Utilities
Pressure Control	Basic Science Concepts and Applications, Hydraulics 2
	Water Transmission and Distribution, Ch. 11 and 12
Public Health Principles	Water Quality, Ch. 1 and 4
	Water Sources, Ch. 6
Public Relations	Water Transmission and Distribution, Ch. 16
Pumps	Basic Science Concepts and Applications, Hydraulics 6
	Water Transmission and Distribution, Ch. 12
Quality Control & Assurance	Water Quality, Ch. 9
	Water Treatment, Ch. 2
Recordkeeping	No reference source specified
Reverse Osmosis	Water Treatment, Ch. 15
Safety Administration	No reference source specified
Science	Basic Science Concepts and Applications, Chemistry 2 - 6
Screening	Water Treatment, Ch. 3
Sludge Centrifuges	No reference source specified
Sludge Conditioning	No reference source specified
Sludge Drying Beds	No reference source specified
Softening	Water Treatment, Ch. 11
Sources & Characteristics	Water Sources, Ch. 1-3 and 6

	Water Treatment, Ch. 2
Storage	Water Transmission and Distribution, Ch. 7
Taste & Odor Control	Basic Science Concepts and Applications, Chemistry 7
	Water Treatment, Ch. 7 and 13
Units of Expression	Basic Science Concepts and Applications, Chemistry 7 and Mathematics 11
Valves	Water Transmission and Distribution, Ch. 3
Well Operation	Basic Science Concepts and Applications, Mathematics 23
	Water Sources, Ch. 2

Appendix N

Cross Connection Control Specialist (CCS)

Examination Information

The questions on this examination are all multiple choice. Hand-held numeric calculators may be used. Formulas and conversion factors are provided in each examination packet, and are presented in *Appendix P/Q*. Below is the exam description.

Causes of Backflow

- What is a Cross Connection
- Backflow
- Hydraulics of Backsiphonage
- Water Pressure
- Backsiphonage Due to the Siphon Principle
- Backsiphonage Due to High Velocities in Pipelines
- Backsiphonage Due to Capillary Action
- Backpressure
- Examples of Backpressure

Health Aspects

- History of Backflow Incidents
- Physical hazards
- Aesthetic Considerations
- Communicable Disease
- Chemical Hazards
- Additional Information

Legal Aspects

- Regulations
- Contracts
- Common Law

Recommended Backflow Prevention Procedures

- Degree of Hazard
- Probability of Occurrence
- Reliability of Backflow Preventers
- Assessment of Risk
- Selection of Backflow Preventers

Application of Backflow Prevention Procedures

- Premise Isolation Practice - Typical Facilities
- Backflow Prevention - Typical Distribution System Hazards

Types of Backflow Preventers

- Approved Air Gap Separation
- Mechanical Backflow Prevention Assemblies and Devices
- Design and Material Specification
- Design of Backflow Prevention Assemblies
- Design of Backflow Prevention Devices
- Alternative Piping Arrangements

Recommended Installation Practice

- General Installation Requirements
- Installations Requiring Continuous Service
- Installation Requirements Specific to Assemblies
- Atmospheric Vacuum Breaker Device
- Freeze Protection

Recommended Testing Procedures

- Test Procedure for Reduced Pressure Backflow Assembly Using Differential Gauge
- Test Procedure for Double Check Valve Assembly Using Differential Gauge
- Test Procedure for Pressure Vacuum Breaker and Spill-Resistant Vacuum Breaker Assemblies Using Different Gauge

Recommended Cross Connection Program

- Program Administration
- Summary of Steps to Implement Program
- Program for Small Water Purveyors

Regulations

- CCS Regulations
- Professional Growth

The passing score for this exam is 70%.

Study References

See Appendix O

Appendix O

Study Materials

Water Distribution Specialist (WDS)	Water Distribution System O & M – California State University (Ken Kerri) Water Treatment Plant Operation Vol. 2 - California St. University (Ken Kerri) AWWA - Operator Certification Study Guide - WETRC AWWA - Water Distribution Training Handbook - WETRC Water Transmission and Distribution – AWWA Bookstore Basic Science Concepts and Applications – AWWA Bookstore
Water Distribution Manager (WDM)	Water Distribution System O & M - California State University (Ken Kerri) Water Treatment Plant Operation Vol. 2 - California St. University (Ken Kerri) AWWA - Operator Certification Study Guide - WETRC AWWA - Water Distribution Training Handbook – WETRC Water Transmission and Distribution – AWWA Bookstore Basic Science Concepts and Applications – AWWA Bookstore
Basic Treatment Operator (BTO)	Small Water System Operation and Maintenance, A Field Study Training Program - California State University (Ken Kerri) AWWA - Operator Certification Study Guide - WETRC Group A Public Water Systems Chapter 246-290 WAC - DOH Slow Sand Filtration - ASCE Water Filtration For Point-Of-Use Application - Water Quality Assoc.
Water Treatment Plant Operator (WTPO)	Water Treatment Plant Operation Vol. 1 - California St. University (Ken Kerri) Water Treatment Plant Operation Vol. 2 - California St. University (Ken Kerri) AWWA - Operator Certification Study Guide - WETRC Manual Of Instruction For Water Treatment Plant Operators – WETRC Water Treatment – AWWA Bookstore Basic Science Concepts and Applications – AWWA Bookstore
Cross Connection Control Specialist (CCS)	Cross Connection Control Manual, Accepted Procedure & Practice Handbook – PNWS-AWWA Manual of Cross Connection Control, 9 th Edition – USC Recommended Practice for Backflow Prevention & Cross Connection Control – AWWA Cross Connection Control Manual (WH-550) - USEPA Backflow Prevention Assemblies Approved For Installation In Washington State - DOH

Prices for study materials vary, therefore, please contact the appropriate source.

Dept of Health Operator Certification PO Box 47822 Olympia, WA 98504-7829 Toll Free 1-800-525-2536 (360) 236-3141 Website: www.doh.wa.gov/ehp/dw	Washington Environmental Training Center (WETRC) 12401 SE 320th Street Auburn, WA 98092-0858 Toll Free 1-800-562-0858 (253) 833-9111 Ext 3369 Website: www.wetrc.org	AWWA Bookstore 6666 West Quincy Avenue Denver, CO 80235 Toll Free 1-800-926-7337 Website: www.awwa.org
PNWS/AWWA 9100 Mangan Drive Clackamas, OR 97015 1-877-767-2992 or (503) 655-4075	Water Quality Assoc 4151 Naperville Road Lisle, IL 60532-1088 (630) 505-0160 Fax (630) 505-9637 Website: www.wqua.org	American Society Of Civil Engineers 1801 Alexander Bell Dr Reston, VA 20191 1-800-548-2723 or (703) 295-6200 Website: www.asce.org
Foundation of Cross-Connection Control and Hydraulic Research University of Southern California KAP-200 University Park MC-2531 Los Angeles CA 90089-2531 (213) 740-2032	CSUS Foundation, Office of Water Programs (Ken Kerry) 600 J Street Sacramento, CA 95819-6025 (916) 278-6142 Fax (916) 278-5959 Website: www.owp.csus.edu Email: wateroffice@owp.csus.edu	USEPA Water Resource Center (RC4100) Room 2615 401 M Street Washington, DC 20460 (202) 260-7786

Appendix P

Washington DOH Water Works Exam Formula Sheet

Conversions

1 acre	=	43,560 square feet
1 cubic foot	=	7.48 gallons
1 cubic foot	=	1,728 cubic inches
1 cubic foot (water)	=	62.4 pounds
1 cubic yard	=	27 cubic feet
1 gallon	=	3.785 liters
1 gallon	=	8 pints
1 gallon	=	231 cubic inches
1 gallon (water)	=	8.34 pounds
1 grain/gallon	=	17.12 mg/L
1 gram	=	15.43 grains
1 horsepower	=	33,000 foot lbs/min
1 horsepower	=	746 watts
1 inch	=	2.54 centimeters
1 meter	=	1.09 yards
1 mile	=	5,280 feet
1 mile	=	1,760 yards
1 ounce (weight)	=	28.35 grams
1 pound	=	454 grams
1 pound	=	7,000 grains
1 PPM	=	1 mg/L
1 square foot	=	144 square inches
39.37 inches	=	1 meter
1 MGD	=	694 gpm
1 cfs	=	449 gpm

C	=	circumference
cfm	=	cubic feet per minute
cfs	=	cubic feet per second
cu ft	=	cubic feet
D	=	diameter of depth
ft lbs/min	=	foot pounds per minute
ft ²	=	square feet
ft ³	=	cubic feet
g	=	Gram
gpg	=	grains per gallon
gpd or GPD	=	gallons per day
gpm or GPM	=	gallons per minute
gps or GPS	=	gallons per second
gr.	=	grain
H	=	height

Washington DOH Water Works Exam Formula Sheet

L	=	length
lbs of lb	=	pounds
MG	=	million gallons
mg/L	=	Milligrams per Liter
MGD	=	million gallons per day
PPM	=	parts per million (pounds per million pounds)
psi of PSI	=	pounds per square inch
PSIG	=	pounds per square inch gauge
R	=	radius
sq ft	=	square feet

Areas and Volumes		
π	=	3.14
π	=	C/D
circumference	=	πD
Areas in square inches or feet or yards		
Area of a Triangle	=	$(\text{Base} \times \text{Height}) \div 2$
Area of a Square	=	Length X Width
Area of a Circle	=	πR^2
Volumes in cubic inches or feet or yards		
Volume of a Cylinder	=	$\pi R^2 \times \text{Length, Height or Depth}$
Volume of a Tank (square)	=	Length X Width X Depth
Volume of a Cone	=	$1/3 \pi R^2 \times \text{Length}$
Volume of a Sphere	=	$1/6 \pi D^3$
Gallons	=	cubic ft X 7.48 gal/ft ³

Head and Pressure		
1 PSI	=	2.31 ft of water
1 ft of water	=	0.433 PSI
ft of head	=	$\frac{\text{PSI}}{0.433 \text{ PSI/ft}}$
PSI	=	$\frac{\text{ft of head}}{2.31 \text{ ft/PSI}}$
PSI	=	ft of head X 0.433 PSI/ft
ft of head	=	PSI X 2.31 ft/PSI

Washington DOH Water Works Exam Formula Sheet

Flow		
Q (quantity)	=	flow in cfs or cfm
V (velocity)	=	velocity in ft/sec or ft/min
A (area)	=	cross section in ft ²
$Q = VA$		
$V = Q / A$		
$A = Q / V$		
MGD	=	gal per day \div 1,000,000
gpm	=	gal per day \div 1,440 min per day

Available Chlorine

Chlorine Gas = 100%
 Household Bleach (sodium hypochlorite) = 5.25%
 Commercial Bleach (sodium hypochlorite) = 12 - 15% by weight
 Granular (calcium hypochlorite) 60 - 70% by weight

Weight of bleach (8.34 lbs/gal) X % available = lbs Cl₂ per gal

Weight of 100% Cl₂ ÷ % available = lbs granular Cl₂

Formulas

PPM	=	$\frac{\text{pounds of 100\% chemical}}{\text{MGD or MG X 8.34 lbs/gal}}$
mg/L	=	$\frac{\text{pounds of 100\% chemical}}{\text{MGD or MG X 8.34 lbs/gal}}$
lbs of 100% chemical	=	MGD or MG X 8.34 lbs/gal X mg/l
lbs of 100% chemical	=	MGD or MG X 8.34 lbs/gal X PPM
lbs of < 100% chemical	=	$\frac{\text{MGD or MG X 8.34 lbs/gal X mg/l}}{\% \text{ available}}$
lbs of < 100% chemical	=	$\frac{\text{MGD OR MG X 8.34 lbs/gal X PPM}}{\% \text{ available}}$
Velocity	=	$\frac{\text{distance}}{\text{time}}$

Formulas

Water Horsepower	=	$\frac{\text{gpm X head in ft X 8.34 lbs/gal}}{33,000 \text{ ft lbs/min}}$
Brake Horsepower	=	$\frac{\text{gpm X head in ft X 8.34 lbs/gal}}{33,000 \text{ ft lbs/min X pump efficiency}}$
Wire Horsepower	=	$\frac{\text{brake horsepower}}{\text{motor efficiency}}$
Detention Time	=	$\frac{\text{volume}}{\text{time}}$
Rate of Filtration	=	$\frac{\text{gpm}}{\text{sq ft of filter area}}$
Celsius	=	$0.56 \text{ X } (^{\circ}\text{F} - 32)$
Fahrenheit	=	$(1.8 \text{ X } ^{\circ}\text{C}) + 32$
Average Daily Water Use per Capita	=	$\frac{\text{total water used}}{\text{number of people served}}$

Appendix Q

Association of Boards of Certification (ABC)

Exam Formula/Conversion Table

Alkalinity	= $\frac{(\text{mL of Titrant})(\text{Acid Normality})(50,000)}{\text{mL of Sample}}$
Area of a Circle	= $[(0.785)(\text{Diameter}^2)]$ or $(\pi)(\text{Radius}^2)$
Area of a Cylinder	= $[(0.785)(\text{Diameter}^2)] + [(\pi)(\text{Diameter})(\text{Height})]$
Area of Rectangle	= $(\text{Length})(\text{Width})$
Area of Triangle	= $\frac{(\text{Base})(\text{Height})}{2}$
Chemical Feed Pump Setting, % Stroke	= $\frac{(\text{Desired Flow})(100\%)}{\text{Maximum Flow}}$
Chemical Feed Pump Setting, mL/min	= $\frac{(\text{Flow, MGD})(\text{Dos, mg/L})(3.785 \text{ L/gal})(1,000,000 \text{ gal/MG})}{\text{Liquid, mg/mL}(24 \text{ hr/day})(60 \text{ min/hr})}$
Circumference of a Circle	= $(3.14)(\text{Diameter})$
Composite Sample Single Portion	= $\frac{(\text{Instantaneous Flow})(\text{Total Sample Volume})}{(\text{Number of Portions})(\text{Average Flow})}$
Detention Time	= $\frac{\text{Volume}}{\text{Flow}}$
Discharge	= $\frac{\text{Volume}}{\text{Time}}$
Dosage, lb/day	= $(\text{mg/L})(8.34)(\text{MGD})$
Efficiency, %	= $\frac{(\text{In} - \text{Out})(100\%)}{\text{In}}$
Feed rate, lb/day	= $\frac{(\text{Dosage, mg/L})(\text{Capacity, MGD})(8.34 \text{ lbs/gal})}{(\text{Available fluoride ion})(\text{Purity})}$
Feed rate, gal/min (Saturator)	= $\frac{(\text{Plant capacity, gal/min})(\text{Dosage, mg/L})}{(18,000 \text{ mg/L})}$
Filter Backwash Rate	= $\frac{\text{Flow}}{\text{Filter Area}}$
Gallons/Capital/Day	= $\frac{\text{Gallons/Day}}{\text{Population}}$
Hardness	= $\frac{(\text{mL of Titrant})(1,000)}{\text{mL of Sample}}$
Horsepower	= $\frac{(\text{Flow, gpm})(\text{Head, ft})}{(3,960)(\text{Efficiency})}$
Hydraulic Loading Rate	= $\frac{\text{Flow}}{\text{Area}}$

Reduction in Flow, %	=	$\frac{(\text{Original Flow} - \text{Reduced Flow})(100\%)}{\text{Original Flow}}$
Slope	=	$\frac{\text{Drop or Rise}}{\text{Distance}}$
Solids Concentration	=	$\frac{\text{Weight}}{\text{Volume}}$
Solids, mg/L	=	$\frac{(\text{Dry Solids, grams})(1,000,000)}{\text{mL of Sample}}$
Surface Loading Rate	=	$\frac{\text{Flow}}{\text{Area}}$
Velocity	=	$\frac{\text{Flow}}{\text{Area}} \quad \text{or} \quad \frac{\text{Distance}}{\text{Time}}$
Volume of Rectangle	=	$(\text{Length})(\text{Width})(\text{Height})$
Volume of Cone	=	$(1/3)(0.785)(\text{Diameter}^2)(\text{Height})$
Volume of Cylinder	=	$(0.785)(\text{Diameter}^2)(\text{Height})$
Waste Milliequivalent	=	$(\text{ml})(\text{Normality})$
Waste Normality	=	$\frac{(\text{Titrant Volume})(\text{Titrant Normality})}{\text{Sample Volume}}$
Weir Overflow Rate	=	$\frac{\text{Flow}}{\text{Weir Length}}$

Conversion Factors:

1 acre	=	43,560 square feet
1 cubic foot	=	7.5 gallons
1 foot	=	0.305 meters
1 gallon	=	3.79 liters
1 gallon	=	8.34 pounds
1 grain per gallon	=	17.1 mg/L
1 horsepower	=	0.746 kilowatts
1 million gallons per day	=	694 gallons per minute
1 pound	=	0.454 kilograms
1 pound per square inch	=	2.31 feet of water
1%	=	10,000 mg/L
Degrees Celsius	=	$(\text{Degrees Fahrenheit} - 32)(\frac{5}{9})$
Degrees Fahrenheit	=	$(\text{Degrees Celsius})(\frac{9}{5}) + 32$

Abbreviations:

ft	=	feet	lbs	=	pounds
gpd	=	gallons per day	mg/L	=	milligrams per liter
gpg	=	grains per gallon	MGD	=	million gallons per day
gpm	=	gallons per minute	mL	=	milliliter